Aviation Week & Space Technology

75 Cents

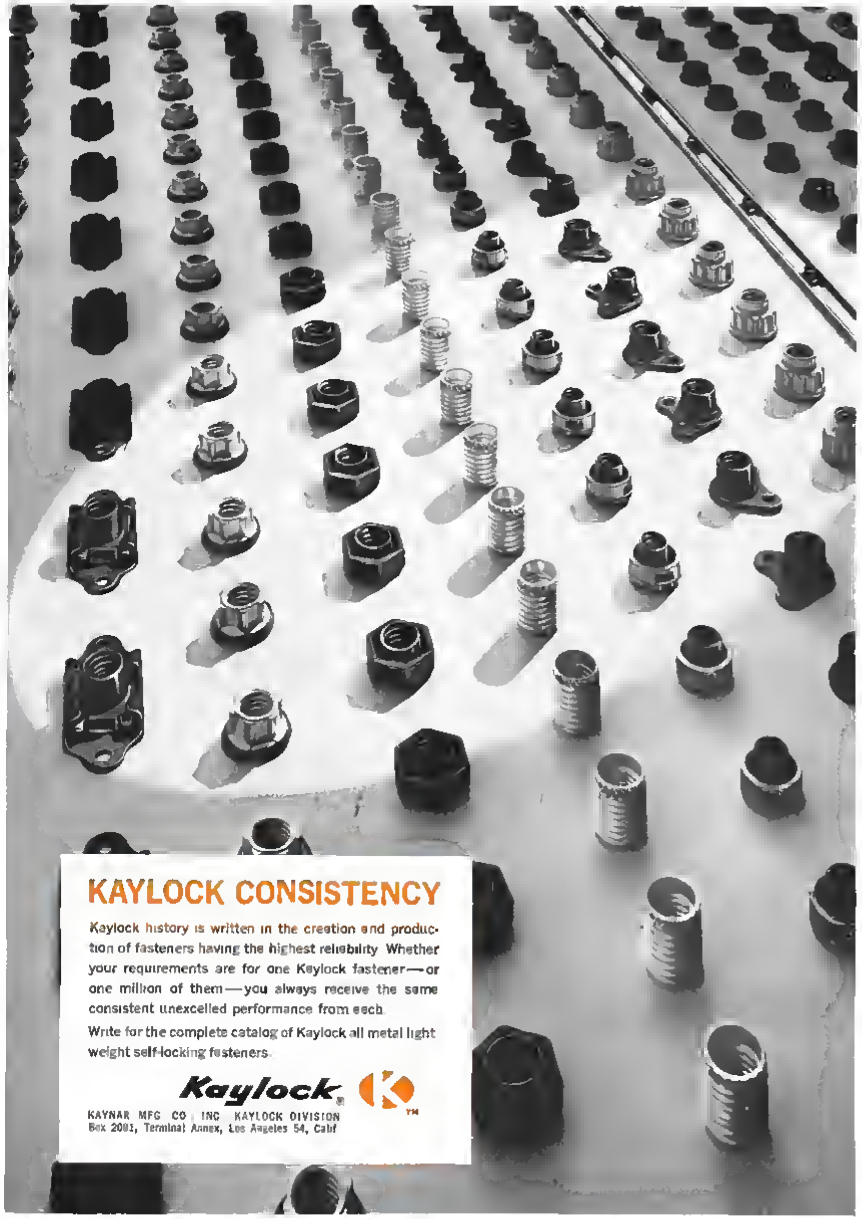
A McGraw-Hill Publication

February 25, 1963

SPECIAL REPORT:

Republic F-105D Modifications

RF-101's Shadow Stalks Cuban Missile Retreat



KAYLOCK CONSISTENCY

Kaylock history is written in the creation and production of fasteners having the highest reliability. Whether your requirements are for one Kaylock fastener—or one million of them—you always receive the same consistent unexcelled performance from each.

Write for the complete catalog of Kaylock all metal light weight self-locking fasteners.

Kaylock®

KAYNAR MFG. CO., INC. KAYLOCK DIVISION
Box 2001, Terminal Annex, Los Angeles 54, Calif.

The red line tells you: This is the world's most reliable jet tire

New Goodyear Red Streak jet transport tire is so ruggedly built—it delivers as much as 15% more landings per tire—and airline records prove it.

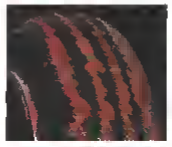
Here's what's back of the amazing record—15% more landings per tire—compiled by major airlines in the first year the Goodyear Red Streak jet tire has been available:

Shredded Wire Shield

First, a shredded wire shield protects the carcass by resisting cuts and cut-growth problems which frequently necessitate early tire changes and prevent tire retreading.

Reinforcing Tread Ply

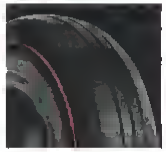
Next, reinforced tread ply design permits use of extra rubber in the tread. It protects tires from hazardous tread chunking and peeling under severe high-speed, heavily loaded jet transport operating conditions.



Automatic Wear Indication

When 80% of the tread is worn, this red reinforcing ply begins to show. It makes tire inspection easier, tells when tire-change time is near. And unlike other wear indicators, it makes the tire stronger.

Low-Profile Rib Tread Design . . .



. . . puts more rubber where the tire meets the runway, increases tread life. Special tread design furnishes the best balance for maximum tread wear and coefficient of friction under all conditions, snow or ice, wet or dry.

Plus Many Other Features . . .

. . . specially compounded tread rubber, computer-calculated balanced ply construction, super-strength beads, high-pressure cures and quality control that checks the tire 140 times during its production. It all adds up to . . .

. . . The Best Jet Tire Buy in the Business

Get full details on the Red Streak—world's most reliable jet tire. Write Goodyear, Aviation Products, Dept. B-1715, Akron 16, Ohio.

GOODYEAR
AVIATION PRODUCTS

AEROSPACE CALENDAR

Mar 3-7—Aviation & Space Hydraulics Gas Turbine Conference & Products Show American Society of Mechanical Engineers, Statler Hilton Hotel, Los Angeles

Mar 4-5—Space Age Technology Measurement Symposium, Stanford Research Institute, Palo Alto, Calif

Mar 4-10—Third Inter-American Symposium of Astronautics, Ibirapuera Park Sao Paulo Brazil

Mar 6-7—Disc File Symposium, Hollywood Thunderbird Inn, Hollywood, Calif Sponsor Informatics, Inc

Mar 6-8—Annual Meeting American Ordnance Assn s Packaging Division, Brookley AFB, Ala Host Air Force Packaging Laboratories, Mobile Air Materiel Area

Mar 7-8—National Propulsion Meeting, AIAA/NASA Lewis Research Center, Hotel Carter, Cleveland (Classified)

Mar 11-12—Image Enhancement Seminar, Society of Photographic Instrumentation Engineers St Louis Mo

Mar 11-13—Electric Propulsion Conference, American Institute of Aeronautics and Astronautics (AIAA), Broadmoor Hotel, Colorado Springs Colo

Mar 15-16—Pacific Computer Conference Institute of Electronic and Electrical Engineers, California Institute of Technology, Pasadena, Calif

Mar 18-20—Space Flight Testing Conference, American Institute of Aeronautics and Astronautics Cocoa Beach Fla

Mar 18-21—1963 Western Metal Exposition and Congress, Pan Pacific Auditorium/Ambassador Hotel, Los Angeles

(Continued on page 7)

AVIATION WEEK & Space Technology

February 25, 1963

Vol 78, No 8

Published weekly with an additional issue in December by McGraw-Hill Publishing Company James H McGraw (1860-1948) Founder See panel below for directions regarding subscription or change of address. Executive Editorial Circulation and Advertising Offices McGraw-Hill Building 330 West 42nd Street, New York 36 N Y Printed at Albany, N Y OFFICERS OF THE PUBLICATIONS DIVISION Shelton Fisher President, Vice Presidents George H. Reppert, Jr Operations; John R. Callaham Editorial; Ervin E DeGraff Circulation; Donald C McGraw Jr Advertising Sales; Angelo R. Venezian, Marketing OFFICERS OF THE CORPORATION Donald C McGraw President; Hugh J Kelly, Harry L Waddell Executive Vice Presidents; L. Keith Goodrich Executive Vice President and Treasurer; John J Cooke Vice President and Secretary

Available only by paid subscription. Publisher reserves the right to refuse non-qualified subscriptions. Subscriptions to Aviation Week solicited only from persons who have a commercial or professional interest in aviation including missiles and space technology. Position and company connection must be indicated on subscription orders forwarded to address shown in box below.

Single copies 75¢ Subscription rates—United States and possessions $7 one year Canada, $8 one year All other countries $20 one year

Our primary aim is to provide subscribers with a useful and valuable publication. Your comments and suggestions for improvement are encouraged and will be most welcome. The publisher, upon written request, agrees to refund the part of the subscription price applying to the remaining unfilled portion of the subscription—if service is unsatisfactory

Second class postage paid at Albany, N. Y. Printed in U S A. Title registered in U S. Patent Office.

Cable Address McGraw-Hill New York. Publications combined with AVIATION WEEK & SPACE TECHNOLOGY are AVIATION, AVIATION NEWS, AIR TRANSPORT, AERONAUTICAL ENGINEERING and AIRCRAFT JOURNAL. All rights to these names are reserved by McGraw-Hill Publishing Co

Subscribers Send correspondence and change of address to Fulfillment Manager Aviation Week 330 West 42nd Street New York 36, N Y. Subscribers should notify Fulfillment Manager promptly of any change of address, giving old as well as new address including postal zone number. Enclose recent address label if possible. Allow one month for change to become effective

Postmaster Please send form 3579 to Fulfillment Manager Aviation Week & Space Technology, 330 West 42nd Street New York 36, N Y

AEROSPACE CALENDAR

(Continued from page 5)

Mar 18-22—Spring National Convention, Society for Nondestructive Testing. Ambassador Hotel, Los Angeles, Calif.

Mar. 19-21—Second Air Force-sponsored Symposium on Bionics, Biltmore Hotel, Dayton, Ohio.

Mar. 22—Sixth Annual Dr. Robert H. Goddard Memorial Dinner, Sheraton-Park Hotel, Washington, D.C. Sponsor: National Rocket Club.

Mar. 25-28—International Convention, Institute of Electrical and Electronics Engineers. Waldorf-Astoria and Coliseum, New York, N.Y.

Mar. 25-29—Fifth International Symposium on Electron Beam Technology, Hotel Sheraton Plaza, Cambridge, Mass. Sponsor: Alloyd Electronics Corp.

Apr. 1-3—Launch and Space Vehicle Shell Structures Conference, American Institute of Aeronautics and Astronautics, El Mirador Hotel, Palm Springs, Calif.

Apr. 2-3—Eighth Annual Business Aircraft Safety Seminar, Flight Safety Foundation, Barbizon Plaza, New York, N.Y.

Apr. 2-5—Spring Conference, Airport Operators Council, Shoreham Hotel, Washington, D.C.

Apr. 8-11—National Aero-Nautical Meeting, Production Forum & Aerospace Support Equipment Conference. SAE/American Society of Naval Engineers, Sheraton-Park Hotel, Washington, D.C.

Apr. 10—1963 National Value Engineering Conference. For information: Dr. David Miller, coordinator of special programs, Los Angeles State College, 5151 State College Dr., Los Angeles 32, Calif.

Apr. 10-11—Fourth Symposium on Engineering Aspects of Magnetohydrodynamics, University of California, Berkeley.

Apr. 16-18—National Meeting, Aerospace Industries Assn.'s Export Committee, Bolling AFB Officers Club, Washington, D.C.

Apr. 16-18—Optical Masers Symposium, United Engineering Center, New York, N.Y. Sponsors: Polytechnic Institute of Brooklyn, Institute of Electrical and Electronics Engineers, American Optical Society, Armed Services.

Apr. 16-19—1963 USAF Aerospace Fluids and Lubricants Conference (unclassified), San Antonio, Tex. Managed by Southwest Research Institute.

Apr. 17-19—Annual Technical Meeting and Equipment Exposition, Institute of Environmental Sciences, Statler Hilton Hotel, Los Angeles, Calif.

Apr. 17-19—International Nonlinear Magnetics (INTERMAG) Conference. Institute of Electrical and Electronics Engineers, Shoreham Hotel, Washington.

Apr. 17-19—Southwestern Conference and Electronic Show, Institute of Electrical and Electronics Engineers, Dallas Memorial Auditorium, Dallas, Tex.

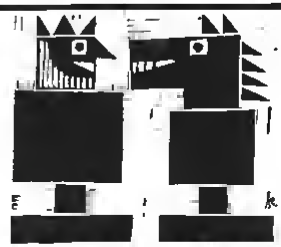
Apr. 17-19—Technical Meeting: Nuclear Materials for Space Applications, American Nuclear Society. Netherland Hilton Hotel, Cincinnati, Ohio.

Apr. 22-23—Annual Meeting, National Aeronautical Services Assn., Washington, D.C.

Apr. 22-24—Second Manned Space Flight

(Continued on page 9)

PROBLEMATICAL RECREATIONS 159



A modernistic chess set has pieces in various geometrical shapes. In particular, both the KING and the KNIGHT are squares of integers. What numbers could these represent if each letter is replaced by a different digit? —*Contributed*

In addition to their nuclear submarines, cargo ships and other surface vessels, our Litton-Ingalls Division is moving ahead on the construction of a new "aircraft-carrier" type ship designed to transport a complete amphibious assault force by helicopter. This new type attack carrier will implement a new concept of warfare developed by the U.S. Marine Corps. Look for the launching of the LPH-10 at Pascagoula, Mississippi.

ANSWER TO LAST WEEK'S PROBLEM: N = 120.

AEROSPACE CALENDAR

(Continued from page 7)

Symposium, AIAA/NASA, Marriott Hotel, Dallas, Tex.

Apr. 22-24—Third Annual San Diego Symposium for Biomedical Engineering, Del Webb's Oceanhouse, San Diego, Calif.

Apr. 23-25—Hypersonic Ramjets Conference, AIAA/ASME, Naval Ordnance Laboratory, White Oak, Md.

Apr. 29-30—1963 Spring Meeting, Western States Section/The Combustion Institute, Vacation Village Motel, San Diego, Calif. Sponsor: General Dynamics/Astronautics.

Apr. 29-May 2—34th Annual Scientific Meeting, Aerospace Medical Assn., Statler Hilton Hotel, Los Angeles, Calif.

Apr. 29-May 2—22nd Annual National Conference, Society of Aeronautical Weight Engineers, Sheraton-Jefferson Hotel, St. Louis, Mo.

Apr. 29-May 3—Annual Conference, Society of Photographic Scientists and Engineers, Ambassador Hotel, Atlantic City, N.J. Cosponsor: Army Research Office.

May 1-3—19th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D.C.

May 2—Bioastronautics Conference, AIAA/Aerospace Medical Assn., Los Angeles, Calif.

May 2-3—Fourth National Symposium on Human Factors in Electronics, Institute of Electrical and Electronics Engineers, Marriott Twin Bridges Motel, Washington, D.C.

May 2-5—International Travel Fair and Flying Display, Biggin Hill Airport, Kent, England.

May 5-8—1963 Annual Conference, American Assn. of Airport Executives, Galt Ocean Mile, Beach Club and Coral Ridge Hotels, Fort Lauderdale, Fla.

May 6-8—Aerospace Reliability and Maintainability Meeting, AIAA/ASME/SAE, Washington, D.C.

May 7-9—Electronic Components Conference, Institute of Electrical and Electronics Engineers, Marriott Twin Bridges Motel, Washington.

May 13-15—National Aerospace Electronics Conference, Institute of Electrical and Electronics Engineers (IEEE)/AIAA, Dayton, Ohio.

May 15-17—Connecticut General Flight Forum's Second National Symposium on Air Transportation, Hartford, Conn.

May 20-22—National Symposium on Microwave Theory and Techniques, Institute of Electrical and Electronics Engineers, Miramar Hotel, Santa Monica, Calif.

May 20-22—National Telemetering Conference, Hilton Hotel, Albuquerque, N.M.

May 21-23—Spring Joint Computer Conference, American Federation of Information Processing Societies, Cobo Hall, Detroit, Mich.

May 27-28—Seventh National Conference on Product Engineering & Production, Institute of Electrical and Electronics Engineers, Continental Hotel, Cambridge, Mass.

June 3-11—COSPAR Fourth International Space Science Symposium and Sixth Plenary Meeting, Warsaw, Poland.

June 7-16—25th French International Air Show, Le Bourget, Paris, France.

Reliable Checkout of Pneumatic Systems and Instruments...

Garrett Pneumatic Signal Generators combine laboratory type accuracy with portability, ease of operation and rugged construction for flight line checkout and field maintenance of pressure simulated aircraft and aerospace systems—

Air Data Computing Systems
Flight Instruments
Automatic Flight Control Systems
Pressure Ratio Systems and Transducers

Continued development has resulted in the introduction of the 9070 model pictured above. Half the size and weight of earlier models, this unit has been repackaged to incorporate all the recent advances in this type of equipment.

Unique in these pneumatic signal generators are Garrett-developed servoed pressure regulators which prevent any pressure fluctuation and hold a constant pressure setting indefinitely without drift. Other features include: digital readout for applications requiring extreme accuracy; dynamic testing capability via a pneumatic sine wave for air data computer testing; programming ability for full automatic checkout of systems.

Garrett pneumatic signal generators are in use by NATO forces throughout the world. Modular construction insures that these devices can be designed and manufactured at GML to meet specific requirements. Your inquiries are invited.

GARRETT

GARRETT MANUFACTURING LIMITED / *19 Attwell Drive, Etobicoke, Ontario*

Research, development, manufacturing and sales engineering of systems and components for aircraft, missile, spacecraft, electronic and industrial applications

WHERE WILL THE *THIRD 100* F-27's SERVE?

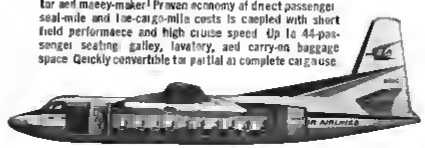
The 200 now flying have proven their unique versatility in a wide range of services — setting new low cost records for local service airlines, saving executive time for large industries, cutting cargo delivery time for critically needed supplies. The third 100 — many already booked for production and delivery — will further prove the F-27's superior performance in many new areas.

The F-27 brings economy, speed and flexibility to *any* service it enters. It can land at or take off from more than 5,500 airports in the U.S. and Canada — and other thousands abroad. Its Rolls Royce Dart turboprop engines provide speed of over 300 miles per hour for high altitude, all-weather cruising. A convenient pneumatically operated step door eliminates ground equipment. Original investment, and operating and maintenance costs, are unusually low for an aircraft of the F-27's versatility. The F-27 now serves U.S. and foreign airlines, leading corporations, and is now under consideration by the U.S. military. Owners report unexcelled performance . . . *more plane for the money.* For complete information and demonstration, write or call Mr. Richard Henson, Area code 301, 733-3600, Aircraft-Missiles Division, Fairchild Stratos, Hagerstown, Maryland.

** F-27 turboprop-jets are manufactured by Fairchild Stratos Corp. and Fokker Aircraft*

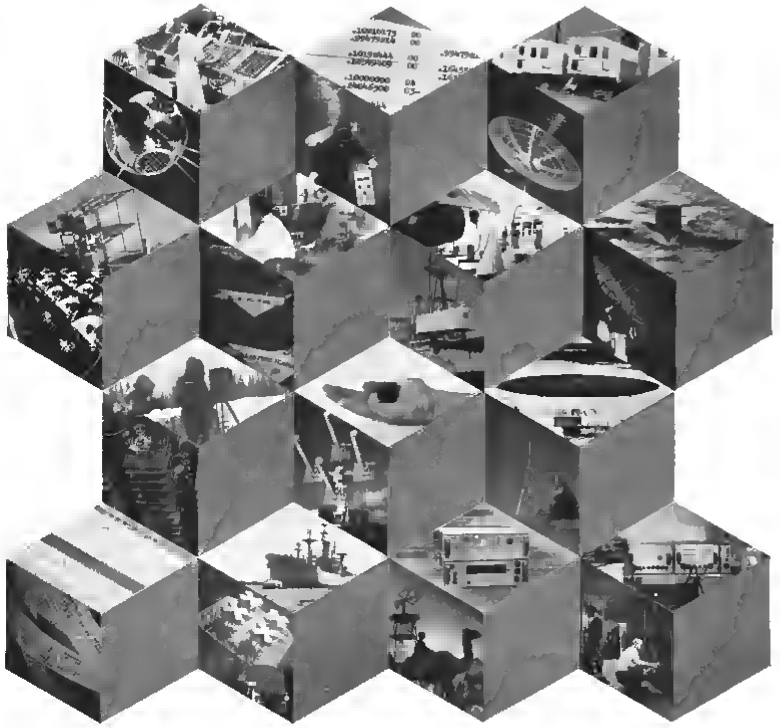
CORPORATE TRANSPORT. F-27-F. Speed, combined with smaller airship requirements, saves executives time. Spacious cabins with stand-up height, larger than those of turbo-prop aircraft cosling much more are custom furnished for "office in the sky" convenience. Quickly converts to cargo use.

AIRLINE TRANSPORT. F-27-A. The modern traffic generator and money-maker! Proven economy of direct passenger seat-mile and ton-cargo-mile costs is coupled with short field performance and high cruise speed. Up to 44-passenger seating; galley, lavatory, and carry-on baggage space. Quickly convertible to partial or complete cargo use.



MILITARY TRANSPORT. F-27-G. Outstanding airlift capabilities! Large cargo door opens to truck bed height for easy loading. Transcontinental range, short field performance, high speed and service ceiling make F-27-G first choice for mission support, passenger, paratroop or aero-medical use.

FAIRCHILD STRATOS



Build your system with operational Cubic AME, DME and DHE...immediately available!

Cubic tracking systems are operational now at installations throughout the free world. They are setting new standards for performance and reliability based on the superior design of Cubic AME (Angle Measuring Equipment), DME (Distance Measuring Equipment), and DHE (Data Handling Equipment). An outstanding example of the capabilities of systems using this equipment is Cubic AGAVE, the primary capsule acquisition aid in use on all 18 Project Mercury tracking sites. Complete systems including peripheral equipment, are built to well defined specifications safety using state-of-the-art techniques.

Cubic tracking systems offer important advantages in lower costs, greater accuracy, prompt delivery and multiple target tracking capability. These systems are easily adapted for real time display or data recording. And most important, they are operational *now* — tried and proved reliable in use.

Here are typical examples of operational systems:

MATTS Three-target AME-based scoring system at Eglin Gulf Test Range.

Bi COTAR AME-based range safety system at Vandenberg Air Force Base.

ELSSE Extremely simple but accurate single target, single AME system for range safety on the Atlantic Missile Range.

AGAVE Primary capsule acquisition aid for Project Mercury.

ADAM A highly sophisticated nine-target position tracking system based on combination of AME and OME.

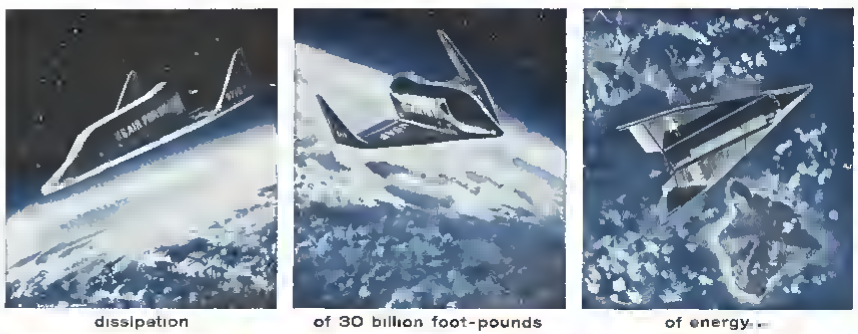
ARCAS Digital data system for Atlantic Missile Range.

For additional information on operational Cubic tracking systems, write to Department B-115

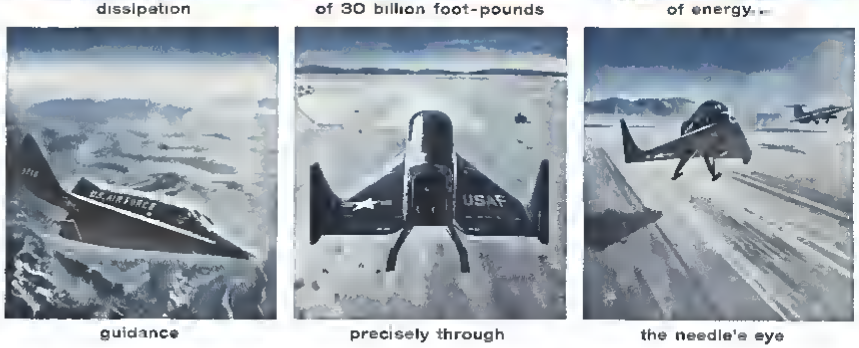
OTHER OFFICES: Washington, D.C. • Cocoa Beach, Florida • Los Angeles, California • Boston, Massachusetts

CUBIC CORPORATION
SAN DIEGO, CALIFORNIA

Acquisition 100 miles in space...



dissipation of 30 billion foot-pounds of energy...

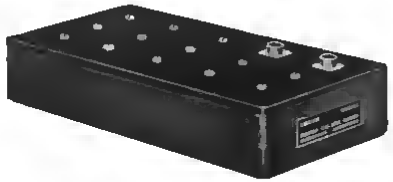


guidance precisely through the needle's eye

Command Recovery. Terminal control and landing of spacecraft...energy management, data links, cockpit displays for aerospace missions. These are not just "long-range objectives" at Sperry Phoenix. For example, we are under contract with USAF Aeronautical Systems Division to capture the X-20 Dyna-Soar vehicle upon re-entry from space, then manage its let-down and landing. This will be done with Sperry microwave guidance and control equipment existing today. We believe we can excel in this USAF assignment because it represents a logical extension of years of Sperry Phoenix experience in high-performance pilotless flight...experience greater in depth and breadth than that of any other company. We welcome new challenges in these and related fields. *SPERRY PHOENIX COMPANY, Phoenix, Arizona.*

SPERRY
DIVISIONS OF SPERRY RAND CORPORATION

Grumman's orbiting astronomical observatory (OAO) will look into outer space.



We'll look after the power.

We call the device you see a static-type battery-charge and sequence controller. It's the first unit of this type for a space application. It does several jobs: keeps battery state-of-charge up to operating limits; charges one battery at a time and maintains standby batteries inoperative; permits the operating battery to discharge during darkness to support spacecraft loads, supports the loads during daylight, if necessary; follows ground command orders; provides data on battery terminal and cell voltages, and system heat-sink temperatures—*all automatically.*

Our background in the electric power field extends over the complete range of power-generating, converting, regulating and supervisory equipment. We have one of the most complete facilities in the industry for designing and producing the aerospace power equipment you need for whatever purpose you need it.

Would you like to have more information? Write us in Eatontown, New Jersey.

Red Bank Division

THE Bendix CORPORATION

Avro Vulcan
Main Undercarriage

UNDERCARRIAGES by DOWTY

DOWTY EXPORTS LTD CHELTENHAM ENGLAND DOWTY ROTOL INC ARLINGTON VIRGINIA USA

Capabilities

for the age of supersonic speed and space travel

Computing Devices of Canada Limited has received world wide recognition as a leader in the fields of airborne integrated navigation systems and displays, photographic systems, advanced electronic instrumentation, aerophysics and space research.

Typical of the advanced air navigation systems which have been created by Computing Devices' unique combination of engineering and manufacturing skills is the PHI (Position and Homing Indicator) in use by the air forces of ten nations of the free world. Other products are VICOM, photo-reconnaissance systems; ANTAC, integrated navigational and tactical control systems for anti-submarine aircraft, head-up and topographical displays, nuclear instrumentation, ground support equipment, and a wide range of field engineering services.

The background of experience and capabilities of Computing Devices are well illustrated in the following list of products and services

AIR NAVIGATION SYSTEMS
- PHI — Position and Homing Indicator
- ANTAC — Air Navigation and Tactical Control System
- GAINS — Global Airborne Integrated Navigation System
- GLANCE — Global Lightweight Air Navigation Computing Equipment
- SKYLINE — Across Track Along Track Air Navigation Computer

PHOTO SYSTEMS
- VICOM Photo Reconnaissance System
- Special Photographic Systems
- Airborne Optical Systems

DISPLAYS
- Tactical Moving Map Display
- SPECTICOM Head up Display

AEROPHYSICS RESEARCH
- Hypervelocity Impact
- Re-entry Aerodynamics
- Plasma Physics
- High "G" Electronics
- Vertical Probes

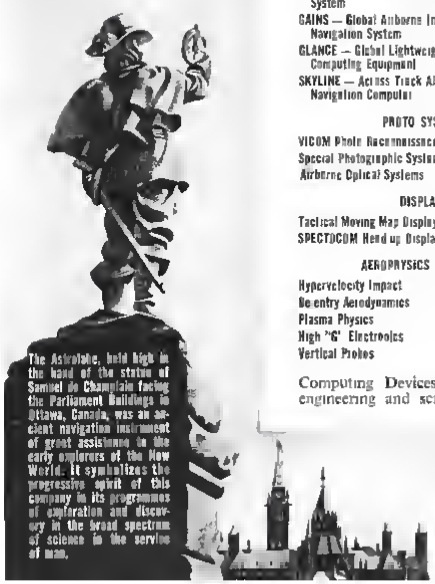
SYSTEMS DESIGN DEVELOPMENT AND MANAGEMENT
- Advanced Systems Engineering
- Product Design and Development
- Avionics Systems Management
- Undersea Warfare Studies
- Oceanographic Surveys

DATA ANALYSIS AND REDUCTION
- Data Processing Techniques
- Data Handling Equipment
- Special Purpose Programming
- Special Purpose Computer Design

MANUFACTURING
- Precision production to Mil Standards
- Government Approved Quality Control
- Environmental Test Facilities

SERVICES
- Technical Assistance and Supervision
- Technical and Operational Training
- Repair and Overhaul
- Technical Manuals

Computing Devices is constantly searching for capable, qualified engineering and scientific personnel. All enquiries are confidential.



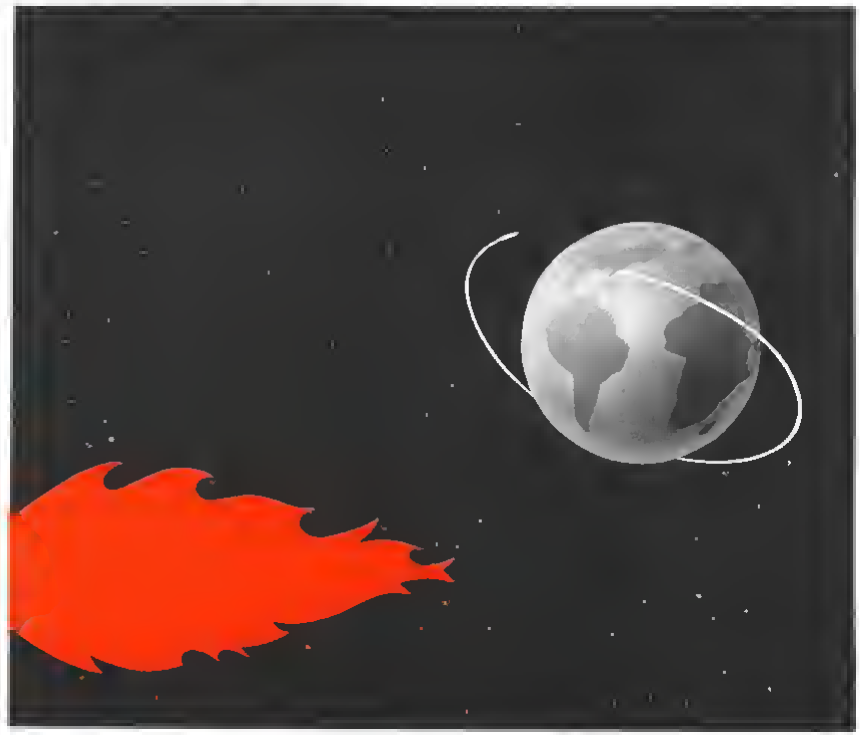
The Astrolabe, held high in the hand of the statue of Samuel de Champlain facing the Parliament Buildings in Ottawa, Canada, was an ancient navigation instrument of great assistance to the early explorers of the New World. It symbolizes the progressive spirit of this company in its programmes of exploration and discovery in the broad spectrum of science in the service of man.

Computing Devices
OF CANADA LIMITED

P O BOX 508 • OTTAWA 4 • CANADA

AN AFFILIATE OF THE BENDIX CORPORATION

C62.13



A world of CUSTOM COATING SERVICE for the "hot" wear problems of aerospace!

A new era of high temperature and wear resistance for airborne working surfaces has been "orbited" by LINDE's *Complete Custom Coating Service!*

Every coating facility—from metallurgical research through development, production, and testing—is available for the application of coatings of tungsten carbide, aluminum oxides, and pure metals to provide top thermal resistance and optimum service life.

LINDE—the "*one-stop*" coating source—evaluates and specifies the right material and coating thickness, the right coating process—utilizing either LINDE's Flame-Plating "detonation gun" technique, or Plasma-Plating with its operating temperatures ranging up to 30,000° F.

With the industry's widest experience in metallic coatings, LINDE's *Complete Custom Coating Service* has the answer to your "hot" wear problems—regardless of the basic material, size, or configuration of the piece involved. If the answer isn't on our shelf—we'll research to get it!

Many of today's important aerospace parts have successfully used Flame-Plated coatings—such as the combustion chamber of the Agena satellite rocket engine, aircraft valves, compressor blades, turbine engine seals, rocker arms, and many others. For many industrial parts, LINDE's "prescription" coatings have increased service life as much as 40 times!

Write for full information today – to Flame Plating Dept., Linde Company, Division of Union Carbide Corporation, 1245 Main St., Indianapolis 24, Ind. *In Canada:* Union Carbide Canada Limited, Linde Gases Division, Toronto 12.

LINDE COMPANY
UNION CARBIDE

FLAME-PLATING: TOMORROW'S COATINGS . . . FOR TODAY'S WEAR PROBLEMS

"Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation

Aviation Week & Space Technology

Volume 78
Number 8

February 25, 1963

EDITORIAL OFFICES New York 36—330 W. 42nd St. Phone LOngacre 4-3000 (Nights LO 4-3035) Washington 4, D. C.—Nat'l Press Bldg. Phone NAtional 8-5414. RL publs 7-8630 Los Angeles 17—1125 West Sixth St. Phone HUdley 2-5450 Dallas 1—1712 Commerce St. Phone Riverside 7-9721 Cape Canaveral—P.O. Box 1838 Cocoa Beach Flr. Phone 783-8703 European Office—1 rue du Temple Geneva Switzerland Phone 32-35-43 London—34 Dover St. London W.1 Eng. Phone Hyde Park 1451

Member AEP and AEC

89,557 copies of this issue printed

CONTENTS

COVER Soviet freighter Kuretov is caught at the Cuban port of Cosildo loading Sandal MRBM missiles for shipment back to Russia by USAF-McDonnell RF-101 photo reconnaissance plane, whose shadow is visible at lower right on dock area. RF-101 made its photo run at 600 ft. on Nov. 6, 1962, to record the removal of Soviet missiles from Cuba. Note the deck load of missiles; rear hatches being closed and Soviet missile crews waiting on dockside to board the ship. A few hours later, other USAF planes photographed the Kuretov leaving port. U. S. photo recon continued until ship neared its home port in Russia.

PICTURE CREDITS
Cover—USAF 27, 29, 54, 55, 107, 109—USAF 34—No. American 38—Northrop 41—Vincent A. Finnigan 78—NASA 98—Plasma General 100—Hawker Aircraft Ltd. 102—Westland Aircraft Ltd. 105—Republic, 110—Bell Helicopter 112, 113—Fairchild Camera

An Excellent Start

Many wondrous things have happened to Theodore von Karman during his 82 years on earth, but certainly one of the finest occurred last week in the Rose Garden adjoining the White House when President Kennedy presented him with the first National Medal of Science (see p. 41). This is a new national honor authorized by Public Law 86-209, passed by the 86th Congress in 1959, and awarded according to procedures established by an Executive Order of Oct. 21, 1961. This order appoints a group of six to twelve distinguished citizens, representing a good cross-section of the major fields of science and engineering, to recommend candidates for the honor. It was certainly wise to include engineering in the scope of this award, since it is characteristic of modern technology that it is becoming harder to separate the scientist from the engineer, and the most significant contributions are now made by men such as Dr. von Karman who combine scientific and engineering disciplines.

The idea for the award germinated in the House Science and Astronautics Committee where Judge Victor Anfuso, then chairman of its advanced research and technology subcommittee, sparked the campaign. Judge Anfuso left the bench in New York to be present in the Rose Garden last week to see the fruition of his work.

White House Attitude

At the time the award was proposed, there was a tendency at the top levels in government to deprecate the contributions scientists and engineers could make in helping to formulate and implement the type of national policies that are essential to survival in the modern world. It was an era when not even the jolts of Soviet Sputniks had changed the White House attitude toward what were disdainfully called "eggheads" and the experience of one presidential dinner for them was so painful to President Eisenhower that the experiment was not repeated. This White House attitude toward achievements of the intellect has changed during the past few years, and the National Medal of Science is certainly an excellent start toward establishing a permanent tradition of placing high national importance on technical achievement which has become such an essential ingredient in the arteries of national vitality.

It was also a wise choice to select a technical titan such as Dr. von Karman as the first recipient of this medal. This places the proper hallmark on the significance of this award more eloquently than any speech and more clearly than any fanfare of publicity. For Dr. von Karman has had a variety of careers, and each has been of such magnitude and impact that it brought him its own crop of honors. His basic work in aerospace sciences is an enduring technical monument, and his unique flavor as a teacher has inspired several generations of students, who in turn are leaving their own indelible marks on the technology of our times.

But Dr. von Karman's greatest contribution has been in bridging the gap between technology and the military, thereby creating the type of defense that has enabled the free world to survive and prosper during the past several decades. His contributions in this area date back to the early days of World War 2 and are still continuing. Along with another man of vision and courage, the late Gen. Henry H. Arnold, he not only enlisted technology in the creation of superior airpower, but also took the lead in educating the military into technical literacy that has enabled them to work more effectively with the technical community.

Technical Perception

Organizer of the Air Force Scientific Advisory Board and creator of the NATO Advisory Group for Aeronautical Research and Development (AGARD), Dr. von Karman was one of the very first to perceive the fantastic shape of the post-war technical future and organize the military technology alliance to shape it effectively into the shield of the free world. Even for those who read them when they were first published, it is an interesting experience today to read the 1945 vintage volumes of "Toward New Horizons," prepared under his direction to guide airpower into the supersonic and space ages, for an appreciation of the acute technical perception and keen understanding of humanity that Dr. von Karman brought to this work.

The atomic bomb blast over Hiroshima shattered the scientists' ivory tower and ended their detachment from the society around them, and no man has taken a stronger lead than Dr. von Karman in applying and integrating the lessons of modern science into the world in which he has spent 82 such fruitful and exciting years. But no formal recital of his achievements can convey those elements of his personality that have lent such extraordinary force to his work and influence, the sparkling wit that can be used with equal dexterity to make a technical point significant or to deflate a gasbag of cant and pomposity, and the warm glow of his presence, which is only partially provided by slivovitz.

The creation of the National Medal of Science and its initial award to Dr. von Karman is an encouraging recognition of the vital role that technology can and must play in the ever-changing pattern of our society. It is not only a well-deserved recognition for Dr. von Karman's lifetime contribution toward this end, but should also serve as an inspiration to American youth to plunge into the ocean of technology and to try to swim as strongly through it as this Hungarian-born, European-trained and American-flowering genius has done.

—Robert Hotz

WHO'S WHERE

In the Front Office

Maj Gen Harold E Watson (USAF ret), formerly deputy chief of staff for foreign technology Air Force Systems Command has joined General Electric's Defense Programs Operation Washington D C as a consultant in aerospace and defense technology Col Raymond S Steeper is now acting deputy chief of staff for foreign technology AFSC

J D Wright board chairman and chief executive officer of Thompson Ramo Wooldridge Inc elected a director of The Goodyear Tire & Rubber Co Akron Ohio

John H Escott, president, Menasco Manufacturing Co's Texas Div Ft Worth Tex, succeeding Donald W Johnson, now assigned responsibilities in the corporate staff

Etienne Henri Larive (AW Jan 21 p 41) temporarily appointed world wide general manager of KLM Royal Dutch Airlines

Rufin Gene Shelley, vice president and general manager Stoddart Aircraft Radio Inc a subsidiary of Tamar Electronics, Inc Anaheim Calif, succeeding Richard R Stoddart, retiring James R Rudmeyer becomes acting general manager of Tamar Electronics Div succeeding Mr Shelley who was vice president and general manager of the division

Theodor H Braun and William W Parsons senior vice presidents System Development Corp Santa Monica, Calif

Bernard Zisman, vice president finance, and Bernard Herman, vice president-operations Loral Electronics Corp New York N Y

Alan C Batsford has been appointed a senior member of R Dixon Speas Associates Manhasset N Y

James Wood formerly vice president and general manager of Rolls-Royce of Canada Ltd now deputy general manager of Rolls Royce Scottish group of factories

Air Chief Marshal Sir Charles Elworthy, now commander in chief Middle East Command, will become British Chief of the Air Staff Sept 1 succeeding Marshal of the Royal Air Force Sir Thomas Pike

Honors and Elections

Dr Leonard S Shemgold of Sylvania Electric Products, Inc has been named a Fellow in the Institute of Electrical and Electronics Engineers (IEEE) for "contributions to microwaves and leadership in military electronics" (AW Apr 24, p 23)

J A McSwigan, traffic manager Flight Propulsion Div General Electric Co's Large Jet Engine Dept has been elected chairman of the Aerospace Industries Assn's Eastern Traffic Committee for 1963 and Vera W Porter traffic manager Columbus Div North American Aviation was elected vice chairman W G Doran director of material for Douglas Aircraft Co has been elected chairman of the AIA's Materials Procurement Committee for 1963 and J W Hinchliffe corporate coordinator of material activities for Northrop Corp was elected vice chairman

INDUSTRY OBSERVER

► Atlas Mark 2, growth version of the basic Atlas, is being studied by USAF Ballistic Systems Div and General Dynamics Astronautics for deployment in Atlas F hardened silos Diameter of the Mark 2 would be about 16 ft, providing more tankage than the present 10 ft Atlas diameter The growth version would be capable of boosting re-entry systems with the highest practical megaton yield over global range Only silo modification believed necessary would be a new elevator system to lift the heavier weight of the Mark 2 missile

► Development of a space-storable rocket propulsion system, capable of maintaining accurate thrust levels over a throttling range of 50 to 1 during a two-year period of intermittent operation, will be supported by USAF's Aeronautical Systems Div Industry proposals for the contract are due Mar 14 About 10,000 on-off cycles are envisioned for a total consumption of 2,100 lb of fuel (equal mixture of unsymmetrical dimethylhydrazine and hydrazine) plus 4,400 lb of oxidizer (nitrogen tetroxide)

► Some industry engineers believe that supersonic transports may have to be restricted to operations between latitudes 50 deg north and 50 deg south during periods of solar flares They feel that solar radiation outside this zone at the altitudes to be used by the supersonic transports may pose a hazard to passengers and crews during these periods Such a restriction would primarily curtail operations over northern polar routes

► Proposals for evaluating porous ceramics for lifting re-entry vehicle nose cap applications will be submitted to USAF Aeronautical Systems Div on Mar 7 In typical environments, orbital vehicle nose caps are expected to experience heat fluxes of 150-200 BTU/sq ft /sec, resulting in surface temperatures of about 4,000F for 5-15 min, and 3,000F for 30-60 min Super-orbital lifting vehicles may experience an additional extremely high heat flux for a short time at the beginning of re-entry.

► During the recent Cuban crisis, all but two of the silo deployed Atlas F ICBMs which had not been transferred by USAF Systems Command to Strategic Air Command because of uncompleted installation and checkout were brought to emergency war order (EWO) status by SAC and contractor personnel This brought the total Atlas alert force to 70 missiles

► Advanced computer methods research for processing neurophysiological data will be funded by USAF Aeronautical Systems Div in a 13½-month program Industry technical proposals are due Mar 11 Cost proposals for the program are due Mar 21 Research will include separation of signals assumed to originate from independent physiological phenomena or from partly correlated processes, such as the same signal transmitted through different nerve fibers

► Evaluation of proposals for the Sprint solid propellant high-acceleration, anti ICBM missile by Army Missile Command and Bell Telephone Laboratories (AW Feb 18 p 23) may result in selection of two contractors for the feasibility demonstration phase AMC may also choose two propulsion contractors for this dual study approach

► National Aeronautics and Space Administration's Marshall Space Flight Center will support an industry study of procedures for monitoring characteristics of large solid-propellant rocket motors, such as temperatures and pressures Program would help determine design requirements for a malfunction detection system Proposals from industry are due Mar 5 Development of such a system would be applicable to motors in the 260-in -dia and larger categories

► USAF's Aeronautical Systems Div will evaluate proposals submitted Feb 25 for manufacturing techniques applicable to monolithic, glass filament wound, 260-in -dia rocket motor cases

Washington Roundup

Mariner 'Cross-Talk'

"Cross-talk" between an infrared and a microwave radiometer in Mariner 2 produced ambiguous data and caused the long delay in NASA's report on Venus' surface and atmospheric temperatures. But work at Jet Propulsion Laboratory, including simulation of the trouble on an identical Mariner test model, is expected to show this week that the surface temperature is "about what you would expect from ground-based observations—in almost 615F"—according to program officials. The possible error in the reading is expected to be reduced to ±50F or less.

Investigation of the F-111 (TFX) contract award will begin Feb. 26 and Senate investigations subcommittee Chairman John McClellan said Defense Secretary Robert McNamara, Air Force Secretary Eugene Zuckert and Navy Secretary Fred Korth will be asked to testify. Most of the hearings will be closed (AW Feb. 18, p. 25).

Joint Atomic Energy Committee hearings on the technical aspects of nuclear test detection (AW Feb. 18, p. 25) now are set for the week of Mar. 4.

Soviet Missile Bubble

Assertions that there is now a Russian "missile gap" are "burst like a soap bubble" by the fact that Russia has more powerful warheads and greater reliability and accuracy in its missiles, Col. Gen. V. F. Tolubko, first deputy commander in chief of Soviet strategic rocket forces, said in the Defense Ministry newspaper, Red Star.

Col. Tolubko asked how one could compare "the power of the biggest American warheads installed in Titan missiles and equalling about 7 megatons of TNT with the Soviet missile warheads whose power attains 100 megatons?"

He also said that "the Soviet Union already has" anti-missile defense weapons.

Publication of excerpts from the diary of Soviet "Cosmonaut K" began in a Moscow newspaper Feb. 14, and the full text is to be published by the magazine Aviation and Cosmonautics. Cosmonaut K said the space pilot training program is being "steadily expanded," and said "If we judge from the present rate of the development of science and technology, flights to the moon and other planets are not far off."

Slayton's Future Role

Maj. Donald K. Slayton has been bombarded with industry job offers since he was grounded as an astronaut, but he has decided to continue as chief of astronaut affairs and as an Air Force officer as long as he remains on flying status. He has 17 years of active USAF duty and would like to serve out 20 years. But he told Aviation Week & Space Technology that if he is taken off flying status, economics may force him to resign from the service and go to work for NASA as a civilian.

George M. Low has been named deputy director for programs in NASA's Manned Space Flight Office. Spacecraft and flight missions, launch vehicles and aerospace medicine directors will report to him. Low formerly was director of spacecraft and flight missions.

Brig. Gen. Charles H. Roadman, director of aerospace medicine in the manned flight office, will end his three-year tour with NASA in June and become Surgeon of the Air Defense Command. Most likely successor is Dr. George M. Knauf, his deputy and former Air Force space medicine specialist.

Lt. Col. Stanley M. White, director of the life systems division at NASA's Manned Spacecraft Center, is expected to transfer soon to USAF's School of Aerospace Medicine.

Pan Am-TWA Case

Plea by Civil Aeronautics Board's Bureau Counsel that procedural steps in the Pan American-TWA merger case be delayed until stockholders vote their approval drew unexpected support last week from Ernest R. Breech, TWA board chairman.

In a speech at Kansas City, Breech called attention to "recent interesting developments in the company's suit . . . against the Hughes interests." He said that, "if as now expected TWA is awarded a substantial default judgment in its favor, the merger agreement will have to be changed to reflect TWA's increased asset position as a basis of exchange of stock in the merged company." It should be easy for Bureau Counsel to convince the Board that procedural steps should be postponed indefinitely, with the transaction still this unsettled.

USAF's Little Theater

Area of space in which Air Force has a military interest has been shrinking by degrees—and decrees—since shortly after the first Sputnik. Once its theater encompassed the universe. Later it became only translunar space—that between the earth and the moon. Last week, USAF Chief of Staff Gen. Curtis LeMay told Congress: "The present area of military interest is within the sphere bounded by the synchronous orbit—an orbit in which a satellite remains in a fixed position over a point on earth. It is in this area that we can augment existing terrestrial defenses through the use of space."

—Washington Staff

USAF Sees X-20 Cancellation or Cutback

Decision due next month; Air Force hopes to use most Dyna-Soar funds for its own Gemini program.

By Edward H. Kolcum

Washington—Air Force expects the X-20 (Dyna-Soar) boost glider program to be canceled or cut back to a feasibility study next month but hopes to use most of the X-20 money for a Gemini spacecraft program of its own, with Air Force capsules, pilots and flight controllers.

Final decision in a Defense Dept evaluation that began 18 months ago is expected next month, after Defense Secretary Robert S. McNamara's visit Mar. 11 to the Boeing Co., developer of the glider, and other contractors. McNamara's trip is expected to include the McDonnell Aircraft Corp plant at St. Louis, where the two-man Gemini capsule is made.

McNamara is being briefed this week on the X-20 program by divisions of the Air Force Systems Command and Boeing officials. Air Force already is a partner with the National Aeronautics and Space Administration in the Gemini program, but in a limited way. The $30 million Air Force now plans to spend for Gemini in Fiscal 1963 and Fiscal 1964 funds was reprogrammed from the X-20 project. NASA's part in the program in these two fiscal years totals $881.7 million.

What Air Force would like to see—whether or not the X-20 is canceled—is a broader participation in the joint Gemini program, and eventually a separate Gemini program of its own, geared to manned interception of satellites.

Titan 3 Future

Optimism over the chance of a larger role in Gemini if the X-20 is canceled is tempered by the possibility that the death of Dyna-Soar might endanger the future of the Titan 3 launch vehicle.

The X-20 is the only payload now assigned to Titan 3 although the vehicle probably will be used for advanced payloads such as heavy reconnaissance and ferrying satellites and synchronously orbiting communications satellites.

Frequent ups and downs of the X-20 (AW Oct. 8, p. 86) have succeeded in generally keeping the program off balance. If the original program approved in early 1960 had been followed, first flights would be made next year. Most optimistic first flight date is now 1966, later than the first three-man earth-orbiting Apollo missions.

Air Force and Boeing have been unsuccessful in convincing Defense Dept. to give X-20 a mission. Among missions proposed were reserve reconnaissance ferry vehicle for space stations and manned interceptors.

X-20 could provide two key technological advancements which cannot be met by Gemini or Apollo:

- **Maneuvering during re-entry.** Both Gemini and Apollo will have offset centers of gravity resulting in aerodynamic lift for maneuvering, but only after re-entry. Lift/drag ratio of Gemini is 0.25, and the vehicle has a 500-mi. by 200-mi. landing footprint. Apollo lift/drag ratio is 0.5, providing a 5,000-mi. by 400-mi. landing footprint. Dyna-Soar has a 2.0-2.5 lift drag ratio. Landing footprint after a single orbit is described as "any airfield between Pt. Barrow and San Diego."
- **Radiation-cooled structures,** which the X-20 would be first to use. Mercury, Gemini and Apollo re-entry vehicles use ablatively-cooled structures and missile nose cones have been built of either ablative materials or heat sinks.

The question of economics naturally enters into the decision on the fate of the X-20, and it boils down to whether exploring these two technological areas is worth the $800 million it would cost for the entire X-20 program. Since USAF officials close to the program concede that the technology could be established through other projects, but not as quickly.

Hypersonic cruise vehicle (AW Feb. 11, p. 26) used as a single stage to orbit system, may explore the maneuvering re-entry and radiator-cooled structure technology, as well as closing the research gap between the X-15 flight corridor and that of orbiting vehicles. Configuration and subsystem work already done on the X-20 may be the basis for a hypersonic vehicle system.

If the anticipated cancellation or cutback of Dyna-Soar takes place the battleground for the military space program shifts to Titan 3 and Gemini. USAF thought it made a strong case for heavy participation in Gemini and considered Gemini an optimum testbed for manned satellite interceptor components, such as sensors, ferreting devices, cameras and "negation" devices.

The Inspector program, formerly called Saint, has been reactivated with USAF Gemini participation after Saint had retreated to a simple demonstration of rendezvous. Saint program was canceled as soon as it became apparent that Gemini would fly and demonstrate rendezvous before Saint could perform these missions. AFSC's Space Systems Div. continues to seek industry advice, however, should Gemini not become the basis of the Inspector satellite.

Air Force would like to buy Gemini capsules, fit them with military experiments and fly them with USAF pilots. With its own program, USAF feels it can control flight tests and obtain manned space flight management experience—which only NASA has at the present.

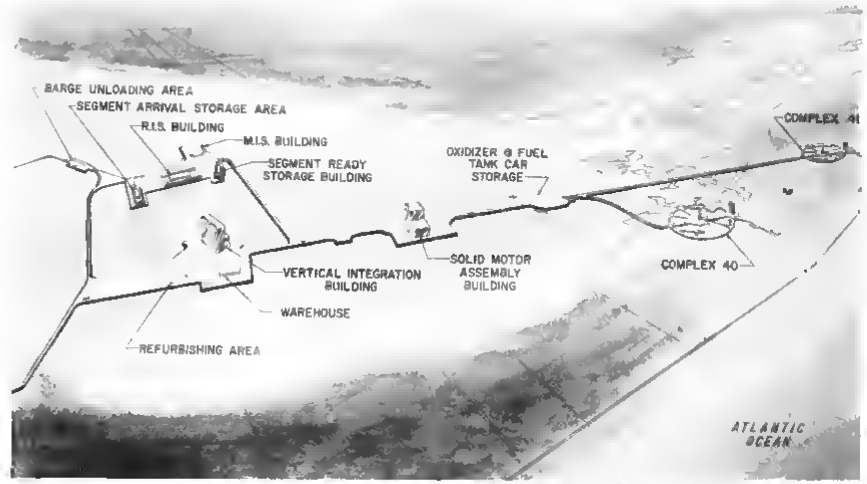
Under terms of the Defense Dept.-NASA Gemini agreement, NASA controls the capsule development and flights. NASA has said it has no objection to Air Force's keeping open the Gemini production line at McDonnell after the civilian agency's order of 15 capsules is filled. Probably as early as the third or fourth flight, USAF will participate in the program by furnishing experiments and co-pilots. But since it is still NASA's program, NASA will manage it and exercise final flight control. USAF is responsible for the Titan 2 Gemini launch vehicle and Agena D target vehicle development.

Brown's Position

Problem of USAF buying its own Gemini program is complicated by the position of Dr. Harold Brown, director of defense research and engineering, that there is no requirement for military man in space. If this view persists, Gemini could represent the beginning and end of military manned space flight for the near future. One USAF observer summed up the situation with this viewpoint: "Air Force has a long way to go before we paint Gemini blue."

Since the X-20 program was started, Congress has appropriated $300.6 million for it through Fiscal 1963. Much of this money remains unspent, and total payments to Boeing through last November for design, development and fabrication of the glider had totalled only $120 million. Anticipated value of the Boeing contract through delivery of an unspecified number of gliders is $330-$375 million.

Titan 3 and the airbitious test schedule for the launch vehicle laid out last week (see p. 27) could be affected unless Air Force ties some additional high-priority payloads to the vehicle. USAF is pushing Titan 3 as a standard launch vehicle, with Titan 3A able to lift 5,000 lb. into orbit, and Titan 3C up to 25,000 lb. in orbit.



USAF TITAN 3 Integrate Transfer Launch (ITL) facility at Cape Canaveral is envisioned in artist's conception. USAF had requested funds for a third launch stand in 1964 budget but this—with a proposal to build an identical facility at Vandenberg was refused by DOD.

Titan 3 Launches to Begin in Fall, 1964

By George Alexander

Cape Canaveral, Fla.—Air Force plans to launch 17 Titan 3 boosters starting in Autumn of next year during a 45-month flight test program which will develop and man-rate this military space vehicle.

Col. Joseph S. Bleymaier, director of the officially-designated 624A program (AW May 21, p. 98) at Air Force Systems Command's Space Systems Div., said here Feb. 15 that the 17 vehicles will include five Titan 3A and 12 Titan 3C configurations. Titan 3A version consists of a modified two-stage Titan 2, called the core, plus a new third stage, called the transtage. It has a payload capacity of 5,800 lb. Titan 3C consists of a Titan 3A plus two 85-ft.-long 120-in.-dia. solid propellant motors affixed to the side of the core. It has a payload capacity of 25,000 lb.

Five Titan 3A vehicles will be flown first and will be launched from Pad 20, formerly a Titan 1 stand, here. The stand is expected to be ready in time for the first 3A launch scheduled for the last quarter of 1964.

Of the five orbital flight regimes considered for Titan 3—low elliptical earth orbit, low circular earth orbit; low circular earth orbit with a Hohmann transfer ellipse into higher earth orbit, synchronous earth orbit and escape—the first two 3A vehicles probably will be programmed only to demonstrate the system's capability in the first and possibly second, regimes. Third, fourth and fifth Titan 3As probably will be used to exercise the system in the second, third and fourth regimes, with the fifth—escape—dependent upon the payload.

Col. Bleymaier, whose nomination to the rank of Brig. Gen. was before the Senate last week, denied that there were any specific payloads now programmed for the Titan 3s aside from the X-20 (Dyna-Soar) spacecraft. He said that primary purpose of these 17 launches will be to qualify and man-rate the launch system and that any payloads—either of USAF, another military agency or the National Aeronautics and Space Administration—could be flown on a piggyback basis. Another USAF project officer said that the primary purpose of the five Titan 3A launches will be to proof-test the transtage, which has never yet been flown, and the modified Titan 2.

Transtage, built by the Martin Marietta Corp., builder of the Titan 2 core and 624A system integrator, will be powered by two Aerojet General pressure fed engines of 8,000 lb. thrust each with ablative nozzles. Transtage is expected to be about 16 ft. long, including a guidance and flight control module. Propellant tankage of the transtage, which will burn nitrogen tetroxide and hydrazine as do the two stages of the Titan 2 core, will account for about 10 ft. of this figure. Diameter of the transtage will be 120 in., same as the Titan 2.

Exact performance characteristics of the transtage have not yet been divulged, but one observer said that it will be capable of changing its payload's orbital plane from equatorial to polar. Propulsion system of the unit will be capable of multiple re-starts, although this was not clarified beyond one official's statement that this means "at least two" re-ignitions of the transtage engines. Col. Bleymaier said that the transtage could coast up to 5.5 hr. between engine starts.

First Titan 3C launch, according to Col. Bleymaier, probably will take place early in 1965. First several 3C launches probably will test starting characteristics of the Titan 2 first stage Aerojet engines at altitude. These modified engines will be ignited after burn-out of the United Technology Center solid propellant motors. Precise altitude at which ignition will occur will depend on the mission trajectory, but will never be lower than the area of maximum dynamic pressure—30,000 to 40,000 ft.

Our later 3C launches one source told AVIATION WEEK AND SPACE TECHNOLOGY, it is more than probable that rendezvous maneuvers will be attempted. USAF has indicated that the launch vehicle system could be used for communications satellites, manned satellite inspectors and unmanned space stations. Connection of a specific military payload to a specific booster, aside from the X-20 project, is understood to carry a classification of Secret under

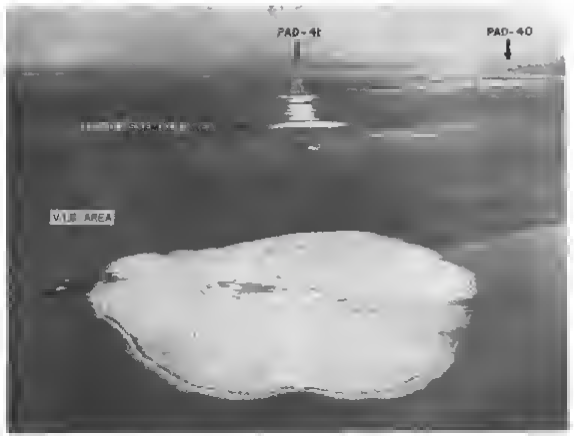


PHOTO SHOWS ITL complex now under construction. Dredges presently are filling in man-made islands, on which the Titan 3 will be built

the terms of last year's Defense Dept space secrecy directive (AW May 21, p 26)

Col Bleymaier, Maj Gen Ben I Funk, commander of Space Systems Div, and other USAF officers were here to witness the formal beginning of construction on the Integrate Transfer Launch (ITL) facility, which they termed as essential a part of the over all 624A system as the launch vehicle itself. Facility will consist of four man-made and inter-connected islands in the Banana River, which flows between the Defense-owned Cape Canaveral reservation and the NASA-owned Merritt Island Launch Area

- **Titan 2 assembly** and system launch control area
- **Solid propellant motor assembly** and integration area
- **Receiving, inspection** and maintenance area
- **Liquid propellant storage area**

The two stages of the Titan 3 core, the transtage, control module, launcher and ground support equipment all will be assembled vertically in a 215-ft tall Vertical Assembly Building located on the first of the four islands listed above. Assembly will be performed on a mil-mounted platform, which also will serve as the launch table for the completed vehicle. Platform will include an umbilical tower.

Ground support and checkout equipment will be housed in several boxcars hooked to the platform. When ready for launch—and no Titan 3 will leave the Vertical Integration Building unless USAF is certain that the vehicle is in a launch-ready condition—two Diesel engines will pull the platform, its Titan 3 unfueled core and the ground support boxcars from the VIB.

If the mission calls for a Titan 3C configuration, the Diesels will move the platform into a 235-ft tall Solid Motor Assembly Building (SMAB) on the second island. There the five segments of a solid propellant engine will have been assembled to form a single 85 ft long motor. two such motors will be placed on the platform on either side of the core and attached to it. If the mission calls for a Titan 3A configuration, the Diesels will by-pass the SMAB and proceed to the launch stands 40 and 41.

Launch stand 40 will be 8,100 ft away from the solid motor island and stand 41 will be 8,100 ft further north of stand 40. Both stands will be on land contiguous to the present Cape reservation.

Diesel engines will push the Titan 3 (either A or C configuration) and its platform up to a launch stand, inserting the boxcars into a fortified bunker adjacent to the pad. A 240-ft tall service tower then will roll forward and enclose the Titan 3 while liquid fuel is loaded, electrical power provided and final preparations made for launch.

This concept of operations, Col Bleymaier said, will provide maximum use of launch facilities. He estimated that it would take five to seven days to assemble a complete Titan 3 vehicle, less than a day to launch it, and three to five days to re-furbish the stand after launch. Turn around time on a stand, he added, should be 15 days or less.

Other USAF officials estimated that the ITL complex could support as many as seven Titan 3 vehicles at one time: one each in stands 40 and 41, one in the solid motor building and four in the vertical building. It could support eight if a 3A vehicle were to be erected on Pad 20. Present estimate of the ITL's yearly launch capability is 40 to 60 Titan 3s. These figures apply only to stands 40 and 41; they would be higher if Pad 20's capability were added.

Two-story launch control center will be built off one end of the Vertical Integration Building and will face the launch stands. There will be two control rooms, each capable of launching a Titan 3 from either stand 40 or 41. Within the limitations of Atlantic Missile Range instrumentation, two Titan 3 vehicles could be launched almost simultaneously—essential for rendezvous.

Titan 3 core elements—i.e., the two stages of the Titan 2, the transtage and control module—will be barged into the ITL and received at the third of the four islands listed above. From there, they will be moved into the VIB. Solid propellant segments will be carried into the same area on a railroad spur. Florida East Coast Railroad will build a spur from the mainland of Florida into NASA's Merritt Island Launch Area. NASA will complete the spur into its own industrial area. USAF will extend this spur into its ITL area. After inspection and acceptance, the segments then will be transported into the solid motor assembly building.

USAF had requested funds for a third launch stand in its 1964 budget but this—with a proposal to build an identical Titan 3 launch facility at Vandenberg AFB, Calif.—was refused by Defense Dept. Third stand at Cape Canaveral is being held in abeyance until a requirement is demonstrated either for a higher frequency of launchings or that three separate payloads must be orbited in a single day.

S-1C Component

Michoud, La.—First hardware component of the Saturn S-1C booster to be manufactured by the Boeing Co. was completed here last week and was scheduled to be shipped to the National Aeronautics and Space Administration's Marshall Space Flight Center in Huntsville, Ala., by the end of the week.

Component was a 33 ft. dia., 15,000 lb. Y-ring which is used to join the elliptical domes of propellant tanks to the cylindrical sides of the tanks. Considered one of the long lead-time items in the manufacture of the S-1C which is the booster stage of the three stage Saturn 5 the ring was two months in fabrication. It is made from three welded aluminum alloy billets each about 5,600 lb., 5 in. thick and about 27 in. deep.

British Planning Blue Steel Replacement

By Herbert J. Coleman

London—British Defense Ministry, which last week said it would increase the 1963-64 defense budget by $325.5 million, is developing a new nuclear standoff air-to-surface weapon to replace the 200-mi. range Avro Blue Steel now becoming operational with Royal Air Force V-Bombers.

Only details revealed to date are that the weapon has been under development for the Blackburn Buccaneer naval strike fighter and the still-secret TSR-2 low-level strike reconnaissance fighter. The weapon is being adapted for a nuclear warhead and probably also will have low-level launch capability.

In effect, the move narrows the nuclear strike gap between the V-bombers' effective life and the operational date for British Polaris submarines in 1968-69 (AW Jan. 21, p. 38).

In a White Paper on defense, which surprisingly did not discuss future policy, the Ministry said it will spend $5,145,500,000 on Britain's defense effort, an increase of $325.5 million over last year.

Breakdown is: Royal Navy, $1,234,700,000, up $52.3 million; Royal Army $1,374,900,000, down $92.1 million; Royal Air Force, $1,409,000,000, down $137 million; Ministry of Defense, $55.9 million, up $4.3 million; buildings and works, a new department, $410.6 million; Ministry of Aviation $645.3 million, up $73.3 million; and Atomic Energy Authority, $15.1 million.

Entire budget is based on closer integration of the three services, under the policy adopted by last year's five-year defense plan (AW Feb. 26, 1962, p. 36). In re-equipment, the newest innovation will be accelerated development of the vertical take-off and landing (VTOL) airplanes with initial concentration on use of the Hawker P.1127 by all three services. The supersonic P.1154 fighter will follow.

Officials said the P.1154 will become the replacement for the Hawker Hunter jet fighter, now being modified for a low-level strike role. VTOL aircraft probably will be powered by the Bristol Siddeley BS.100 vectored-thrust engine, although Rolls-Royce has submitted a design calling for two vectored-thrust Spey turbojets.

Decision also has been to develop a British short take-off and landing (STOL) tactical transport to replace the Blackburn Beverley and Handley Page Hastings, now in use. Designated OR-351, the specification has been apparently downgraded, as predicted by AVIATION WEEK AND SPACE TECHNOLOGY (Feb. 11, p. 40), in view of the emphasis on the words "British" and "short take-off" rather than complete VTOL as originally planned.

In a reference to RAF Bomber Command, the Ministry said special measures were being taken to improve the operational capability of the V-bomber force using the TSR-2 nuclear weapon to stretch effective life up to Polaris integration.

Weapon also may be used to complement Blue Steel in tactical use, the Ministry said. The TSR-2 is scheduled to make its first flight late this year. The program has slipped about six months, primarily due to troubles with sub-service installations. Initial order is for 20 aircraft, but this probably will be expanded considerably.

Reason for the drastic cut in the Royal Air Force budget was buried in small type deep in the estimates section.

Major cut is in the procurement of aircraft and stores, including engines and non-technical stores, although the Ministry said some of the reduction is expected to be offset by increased spending on radios, instruments and other technical equipment, and from sales of equipment. Supplies procurement also was cut, primarily in aviation fuel spending.

Strength of the RAF also will be gradually reduced. Present total strength is 143,500, a cut of 5,400 under last year, and the projection to Apr. 1, 1964, is a further reduction to a total of 137,200.

Royal Air Force will continue to be responsible for maritime reconnaissance, using the Shackleton piston-engine bomber. The Ministry said studies of an eventual replacement, called OR-350, are in progress. However, this requirement is now on a low priority basis and there is no immediate hope for the jet-powered recon aircraft desired by RAF.

There are no requirements for a new fighter, aside from TSR-2, and Fighter Command will continue to use the English Electric Lightning, which will be modified to a Mark 3 version fitted with the de Havilland Red Top heat-seeking missile. In addition the RAF all-weather squadrons, using Javelins, have been re-equipped with Red Top's predecessor, the de Havilland Firestreak, and are now operational in Germany.

The Ministry revealed that the Mark 2 version of the Bristol Bloodhound missile assigned to RAF will be air-transportable. Mark 2 will enter service with RAF next year.

Defense Ministry, noting that the total budget remains within the target figure of 7% of Great Britain's gross national product, said total manpower at present is 432,700. This will increase to 433,700 by Apr. 1, 1964.

Major reason for increase in Royal Navy's budget is the decision to make Polaris the primary nuclear deterrent weapon.

One new British aircraft carrier is being developed, with use of the P.1154 VTOL fighter figuring in the design. The nation now has four operational carriers: the Ark Royal, Victorious, Hermes and Centaur. The new carrier will replace the Victorious.

In the missile field, Royal Navy is bringing Sidewinder air-to-air missiles into service on its Scimitar all-weather jets and has ordered the Nord SS.11 for assault helicopters. Martin Bullpup missiles will be installed on the Buccaneer, now entering squadron service on the Ark Royal.

Defense Minister Peter Thorneycroft said the first Polaris submarines will utilize center sections of U.S. Polaris submarines with Britain building fore and aft sections, using as much as possible of state-of-the-art techniques in British nuclear submarine development.

British army will beef up its anti-tank warfare strength, using the Vickers Vigilant weapon and a new Swedish anti-tank weapon, the Carl Gustaf, for infantry companies. Airlift capability will be considerably expanded when the military version of the Avro 748 enters service, the White Paper said.

T-37Bs for COIN

Cessna Aircraft Co. will modify two T-37B trainers by installing more powerful engines along with other changes to make them suitable for low level counter insurgency warfare as a result of interest shown by USAF's Special Air Warfare Center, Eglin AFB, Fla. Contract is expected to be let soon.

USAF interest stems from evaluation conducted with two T-37Bs last year at Eglin. Indications are that final engine selection has not yet been determined—the present 1,025-lb.-thrust Continental J69s could be replaced either by a more powerful version of the J69 or by GE J85s. Additional fuel capacity would also be provided.

Indications are that USAF also will procure additional T-37B trainer aircraft and is considering buying 83 in Fiscal 1964 and 119 in Fiscal 1965. This would entail increasing T-37B production from 4 to 10 monthly by September, 1964. Defense Dept. also is considering additional purchase of T-37Bs for military assistance program.

NASA Comsat Aid Opposed in Congress

By Katherine Johnsen

Washington—Congressional opposition is developing to further financing of communications satellite programs by National Aeronautics and Space Administration.

The argument emphasized at a public hearing last week by Sen. John O. Pastore (D., R. I.), is that U. S. Communications Satellite Corp., recently incorporated to operate a system on a profit-making basis (AW Feb. 4, p. 31) should assume the risk and responsibility from this point on.

Pastore heads the commerce communications subcommittee, which held two days of briefings on the successful performances of the medium-altitude Telstar and Relay satellites and the disappearance of the high-altitude Syncom satellite about five hours after its launch on Feb. 14 (AW Feb. 18, p. 34).

Preliminary analyses indicate a failure either in the kick rocket, designed to push the satellite from an elliptical to a synchronous circular orbit, or in its telemetry system, according to NASA.

Lt. Col. Robert E. Warren, NASA's deputy director of communications systems, said this to the Pastore subcommittee:

"We know that Syncom is in orbit. If the apogee motor did not fire it is still in the elliptical orbit and will eventually be found, either by optics or by radar. If apogee motor did fire, Syncom is in a very high altitude orbit, and without telemetry, there is only a slim chance that it will be found. A search has been organized which will continue until it is found, or further search seems unwarranted. If it is found, we will have another chance to try out the command system, and if it works, we would again be in business."

NASA's program for continued research into low and medium-altitude systems and a major effort to develop a high-altitude system were defended by Hugh L. Dryden, deputy administrator of NASA. He compared this effort which will contribute to Defense Dept.'s communications satellite program (AW Nov. 19, p. 117) as well as to Communications Satellite Corp. to the government support given the airline industry in the field of air safety.

NASA's Fiscal 1964 budget includes $1.9 million for Relay, built by Radio Corp. of America; $4 million for the 50-lb. Syncom 1, built by Hughes Aircraft Co.; and $40 million for a 500-lb. advanced synchronous communications satellite system.

Although Pastore managed Senate passage last year of the legislation authorizing private operation of a communications satellite system, against the determined opposition of government ownership advocates (AW Aug. 20, p. 36), he warned last week that Congress will take "a very hard look" at any further government outlays for commercial satellites.

When he assumed sponsorship of the private ownership bill, Pastore declared, it was because he had been led to believe the company would take over the financial risks of development. He said that NASA's plans give credence to the opposition argument that "we ought to wait and see what we are giving away."

NASA's financing, now primarily for Syncom, was endorsed at the subcommittee session by Sen. Ralph Yarborough (D., Tex.), one of the leaders of last year's opposition, which contended the private corporation would be dominated by American Telephone & Telegraph Co. Yarborough commented that the government initially has supported "the railroad and almost every other industry."

Pastore and other supporters of the Communications Satellite Corp. have been inclined to favor moving forward with a Telstar or Relay type system, rather than await perfection of a Syncom type system.

Experiences with Telstar and Relay, Dryden told the subcommittee, have reinforced the opinion that considerable research and development must still be performed before economic operational systems can be established.

James E. Dingman, executive vice president of AT&T, estimated that it would be three to four years before a commercial system of 18 medium-altitude satellites—6,000-7,000-mi. orbits—could be established. About 50 would be required for worldwide coverage, he said.

The 12 directors of Communications Satellite Corp. are now arranging credit with several banks for interim financing. Stock issuance to the public and communications carriers is at least several months off.

Twenty-four small telephone companies have filed with the Federal Communications Commission for authorization to purchase from the 50% of the corporation's stock earmarked for communications common carriers. The other 50% will be offered to the public. Dingman confirmed AT&T's general intention to invest. Before going forward with investment planning, AT&T is awaiting further development of the satellite corporation.

These were highlights of the reports on Telstar and Relay:

- **Telstar.** A second failure of Telstar in the near future, due to radiation effects, was anticipated by Eugene F. O'Neill, director of the Satellite Communications Laboratory of Bell Telephone.

  Launched July 10, Telstar worked perfectly until signs of trouble were indicated Nov. 20. On Nov. 23 the satellite failed due to radiation effects. Treatment restored Telstar to perfect operation on Jan. 3 (AW Jan. 4, p. 32). Malfunctioning of the decoder, the first sign of trouble last Nov. 20, appeared again Feb. 5, O'Neill said.

  The radiation intensity inside Telstar has been as much as 100 times greater than anticipated when the satellite was launched into an elliptical orbit of 600 to 3,500 mi. A slight increase in radiation, due to Russian atomic explosions, was detected, but lasted a few days, Dingman reported. He said there is no explanation as to why the radiation exposure of Telstar was so many times greater than calculated.

- **Relay.** NASA expects to require a redesign of Relay's regulator-switch system which apparently permitted power drains on the batteries and resulted in two operational failures of the satellite.

  NASA analysis has indicated that when the battery voltage dropped to a sufficiently low level a subsystem in Relay's communications system ceased operating. With the power drain reduced, the batteries then re-charged.

  Relay's operations first suspended shortly after launch on Dec. 13 (AW Dec. 24, p. 24). The system turned on briefly Dec. 27, but the batteries again drained. Under a procedure to regulate the critical voltage regulator-switch, Relay has been kept in successful operation since it turned on again Jan. 2.

  Launches of second Telstar and Relay satellites are scheduled for the March-May period.

E-2A Performs First Automatic Intercepts

Washington—Navy Grumman E-2A Hawkeye airborne early warning and combat intercept control (CIC) center successfully conducted its first fully automatic intercepts early this month.

Working with McDonnell F-4B fighter aircraft off the New Jersey coast Feb. 4-6, controllers in the development aircraft were able to detect distant targets, and, without voice transmissions of any kind, direct the F-4Bs to intercept and attack the targets.

The E-2A, designed to operate from aircraft carriers is the first Navy aircraft to incorporate automatic control features. Its carrier-based predecessor, the Grumman E-1B, uses manual or voice control procedures to control intercepts.

Program Breakdown of FY1964 NASA Budget

(In millions)

Program	FY64	FY63
Manned spacecraft systems		
Spacecraft		
Apollo		
Spacecraft		
Command, service modules	$661.2	$289.2
Lunar Excursion Module	230.0	32.0
Guidance, navigation	130.1	45.0
Scientific instrumentation	9.5	3.9
Operations	19.0	1.0
Launch vehicles		
Little Joe 2	5.0	4.5
Saturn I	75.0	55.2
Saturn 1B	55.0	
Supporting development	25.0	5.0
R & D facilities		19.9
Personnel costs	29.7	14.2
Operation of installations	26.0	12.8
Total, Apollo	$1,265.1	$402.9
Gemini		
Spacecraft	$196.2	$152.6
Operations	14.0	8.2
Launch vehicles		
Titan 2	48.9	59.2
Atlas R	15.9	8.4
Agena D	32.0	9.9
Supporting development	0.7	5.1
Personnel costs	15.1	7.1
Operation of installations	13.8	9.5
Total, Gemini	$335.3	$249.4
Mercury		
R & D		21.3
Personnel costs	0.1	9.9
Operation of installations	0.1	9.5
Total, Mercury	$0.2	$34.1
Mission control center operations	21.9	10.5
Supporting research	29.9	12.2
Total, manned spacecraft systems	$1,941.4	$769.7
Launch Vehicles		
Saturn S		
S1C stage	$291.9	$144.5
S2 stage	161.4	92.5
S4B stage	82.2	32.1
Instrument unit	11.0	2.6
Guidance system	16.0	11.0
F-1 engine procurement	53.1	21.8
1-2 engine procurement	19.6	9.8
Ground support test	15.0	14.5
Personnel costs	29.0	24.9
Operation of installations	21.1	14.9
Total, Saturn S	$199.1	$368.4
Saturn I		
S1 stage	$28.5	$89.1
S4 stage	25.5	43.7
Instrument unit	3.0	1.3
Guidance system	2.0	12.2
H-1 engine procurement	2.0	1.0
RI 10-A3 engine procurement	2.4	12.7
System integration	30.0	43.9
Personnel costs	32.1	40.0
Operation of installations	32.1	27.2
Total, Saturn I	$158.6	$251.9
Saturn B		
S1B stage	$12.5	$5.0
S4B stage	10.1	10.0
Instrument unit	0.8	
Guidance system	5.2	
H-1 engine procurement	2.1	1.1
J-2 engine procurement	4.2	2.1
System integration	16.9	1.4
Personnel costs	4.5	2.6
Operation of installations	2.9	1.4
Total, Saturn B	$76.8	$22.2
Engine development		
H-1		
Development	$4.5	$4.5
Facilities		0.1
Propellants	0.7	0.6
Personnel costs	0.5	0.4
Operation of installations	0.2	0.2
Total, H-1	$5.7	$5.8
RI 10-A3		
Development	$25.3	$22.2
Test equipment		1.4
Facilities		0.2
Propellants	1.3	0.1
Personnel costs	0.7	0.6
Operation of installations	0.4	0.5
Total, RI 10-A3	$33.7	$33.6
F-1		
Engine development	$43.5	$42.5
Test equipment	2.0	
Propellants	1.6	0.3
Personnel costs	0.8	0.8
Operation of installations	0.5	0.5
Total, F-1	$55.5	$52.1
J-2		
Engine development	$39.6	$35.5
Test equipment	1.4	
Propellants	0.2	0.9
Personnel costs	0.9	0.8
Operation of installations	0.9	0.4
Total, J-2	$49.1	$45.7
M-1 engine		
Engine development	$33.3	$25.1
Test equipment	5.7	9.2
Facilities		1.2
Propellants	0.0	1.5
Personnel costs	1.9	0.9
Operation of installations	0.8	0.3
Total, M-1	$41.1	$38.2
Supporting Technology		
Launch vehicles	$10.9	$8.8
Propulsion	22.5	8.0
Launch operations	7.9	2.0
Emergency costs	1.5	1.3
Operation of installations	1.5	1.0
Total, supporting technology	$50.0	$22.1
Range Support		
USAF salaries and related expenses	$1.0	$9.8
Range contractor support	10.0	1.1
Equipment supplies and material	9.4	2.1
Maintenance, repair and alteration	2.0	1.4
Personnel costs	0.2	0.1
Operation of installations	0.5	0.2
Total, range support	$21.0	$8.3
Range Instrumentation		
Advanced instrumentation	$2.3	
Design data & measurement instrumentation	4.8	
Safety instrumentation	3.4	
Launch support instrumentation	3.0	
Merritt Island launch area	4.5	
Personnel costs	0.2	
Operation of installations	0.8	
Total, range instrumentation	$21.1	
Integration and checkout		
Integration	$20.0	$5.0
Checkout	101.0	26.5
Reliability assessment	26.0	9.0
Personnel costs	1.1	1.4
Operation of installations	2.1	1.9
Total, integration checkout	$159.4	$41.8
Systems engineering		
Systems engineering and studies	$37.0	$26.5
Personnel costs	4.8	4.1
Operation of installations	5.8	4.2
Total, systems engineering	$47.5	$34.9
Aerospace medicine		
Experimental studies	$8.1	$2.9
Crew systems	4.0	5.6
Biomedical in flight experiments	2.1	0.5
Medical operations	1.5	0.2
Personnel costs	2.4	1.8
Operation of installations	2.7	2.0
Total, aerospace medicine	$21.0	$13.0
Totals Manned Space Flight		
Spacecraft development operations	$1,642.4	$766.1
Launch vehicle development	1,219.5	652.8
Supporting programs	229.7	81.5
Center Ops	584.5	535.0
	$3,758.1	$2,242.0
Space sciences		
Lunar planetary exploration		
Ranger		
Spacecraft	$48.3	$44.2
Launch vehicles	41.7	34.8
Personnel costs	0.6	0.8
Operation of installations	0.4	0.4
Total, Ranger	$91.0	$79.8
Surveyor		
Lander	$37.5	$40.2
Orbiter	10.0	1.7
Launch vehicles	42.0	11.7
Personnel costs	0.1	0.5
Operation of installations	0.5	0.4
Total, Surveyor	$98.1	$62.6

(Continued on p. 321)

Program	FY64	FY63
Mariner		
Venus Fly-by		9.1
Mars Fly-by	51.4	24.2
Venus Mars landers	43.4	18.3
Atlas Agena launch vehicles	15.8	5.1
Centaur launch vehicles	9.7	
Personnel costs	1.3	0.8
Operation of installations	1.2	0.5
Total, Mariner	$102.5	$57.9
Pioneer		
Spacecraft	$10.0	$3.5
Launch vehicles	5.0	
Personnel costs	0.4	0.5
Operation of installations	0.4	0.3
Total, Pioneer	$15.8	$4.1
Supporting research & technology	$20.0	$20.2
Total, Lunar, planetary	$331.4	$228.4
Geophysics and astronomy		
Explorer and monitor spacecraft	$11.4	$9.3
Launch vehicles	4.0	11.3
Geophysical observatories	39.8	27.5
Launch vehicles	32.3	11.0
Geodetic satellites	3.4	
Launch vehicles	2.8	
Solar observatories	12.4	8.7
Launch vehicles	4.8	2.7
Astronomical Observatories	37.8	31.8
Launch vehicles	15.1	4.5
International satellites	1.5	2.3
Launch vehicles	5.5	10.8
Sounding rockets program	13.3	11.5
Supporting research technology	15.2	13.7
Personnel costs	19.0	14.8
Operation of installations	19.3	15.1
Total, geophysics & astronomy	$233.0	$174.7
Launch vehicle development		
Centaur vehicle	$93.8	$62.3
SLV-III A3 development	5.1	2.7
Support	12.0	7.9
Personnel costs	4.7	3.8
Operation of installations	1.8	1.3
Total, Centaur	$118.2	$77.0
Operational support		
Product improvement	$10.9	$7.7
Equipment maintenance	2.1	1.2
System engineering	2.0	
Personnel costs	8.7	4.2
Operation of installations	4.2	3.8
Total, support	$28.0	$14.8
Supporting research & technology	$5.0	$2.0
Total, launch vehicles	$149.5	$121.5
Grants		
Facilities	$18.0	$10.0
Training	35.0	15.0
Research	13.0	5.6
Personnel costs	0.5	0.4
Operation of installations	0.9	0.8
Total, grants	$56.4	$31.7
Biosciences		
Bios 3 satellite	$11.7	$8.0
Launch vehicles	12.7	2.2
Supporting research	18.8	18.1
Personnel costs	3.4	2.5
Operation of installations	4.5	1.5
Total, biosciences	$51.3	$25.1
Total, space sciences		
Research & operations	$811.2	$578.0
Construction	45.5	55.8
	$856.7	$634.7
Advanced research technology		
Nuclear rockets		
Nerva		
Engine systems	$11.0	$5.0
Component development	40.0	19.3
Ground test support	13.0	13.7
Propellants	8.0	4.2
Personnel costs	4.1	1.4
Operation of installations	0.7	0.8
Total, Nerva	$82.8	$45.1
RIFT		
Stage system technology	$1.8	$2.3
Subsystem technology	9.8	3.1
System integration	1.5	5.2
Personnel costs	2.8	4.1
Operation of installations	2.5	1.5
Total, RIFT	$18.8	$15.7
KIWI		
Propellants	$1.0	$1.7
Reactor test support components		2.4
Total, KIWI	$1.0	$4.4
Supporting research		
Rocket reactors	$10.2	$8.7
Engine systems	11.2	4.8
Safety	0.5	0.2
Vehicle technology	0.8	0.3
Personnel costs	8.7	7.3
Operation of installations	3.3	2.7
Total, research	$34.7	$24.4
Station operations	$1.7	$0.9
Total, nuclear rockets	$118.9	$89.2
Space vehicle systems		
Re-entry heating		
Scout payload	$0.5	$4.4
Launch vehicle	1.0	1.0
Fire	3.4	5.5
Launch vehicle		4.0
Advanced fire spacecraft	5.6	
Velocity package	1.2	
Launch vehicle	1.7	
Personnel costs	2.8	2.2
Operation of installations	1.2	1.2
Total, re-entry heating	$17.1	$14.4
Meteoroid hazard		
Scout payload	$1.2	$5.7
Saturn payload	4.9	3.0
Total, meteoroid hazard	$6.1	$8.7
Space vehicle recovery	$1.4	
Secondary materials test payloads	$1.2	
Rocket payloads		
Cryogenic propellants	$1.7	0.6
Wind shear measurements	0.8	0.1
Meteor simulation	0.4	0.6
Trailblazer	0.2	0.1
Meteoroid penetration probe	0.5	0.1
Personnel costs	1.7	1.4
Operation of installations	1.0	0.9
Total, rocket payloads	$6.2	$4.2
Supporting research technology		
Advanced concepts	$4.1	$2.4
Spacecraft aerothermodynamics	5.9	4.8
Spacecraft loads & structures	8.1	4.4
Environmental factors	9.8	5.1
Vehicle aerothermodynamics	4.4	3.6
Vehicle loads & structures	6.1	4.5
Space vehicle design criteria	1.5	0.5
Personnel costs	27.1	24.7
Operation of installations	15.9	12.8
Total, supporting research	$78.8	$64.0
Total, space vehicle systems	$111.4	$89.8
Nuclear electric systems		
Supporting research		
Basic power properties	$1.5	$1.7
System components	5.7	4.8
Materials & effects	3.9	2.4
Advanced concepts	1.0	1.2
Subsystem evaluation	0.8	
Electrostatic propulsion	1.9	1.8
Electrothermal propulsion	0.5	0.8
Electromagnetic propulsion	2.4	1.7
Mission analysis	0.4	0.4
Personnel costs	10.7	9.1
Operation of installations	4.8	3.9
Total, supporting research	$35.0	$28.1
Snap 8		
Research	$15.0	$15.1
Spacecraft design	5.5	8.5
Supporting spacecraft research	1.0	0.4
Ground launch support	2.0	0.1
Thor launch vehicles		0.5
Personnel costs	2.3	1.9
Operation of installations	1.0	1.0
Total, Snap 8	$27.0	$18.7
SERT		
Spacecraft	$8.7	$4.8
Launch vehicles (Scout, Thor, Agena, Delta)	4.7	0.8
Personnel costs	0.9	0.8
Operation of installations	0.5	0.4
Total, SERT	$14.8	$6.4
Electric engines		
30 kw-1.5 mw ion engines	$6.0	$3.8
30 kw arc jet engines	0.5	0.5
Small arc jet engines	1.5	1.2
Personnel costs	0.3	0.3
Operation of installations	0.1	0.1
Total, electric engines	$8.4	$5.9
Project MECA		
Research	$1.4	$1.9
Personnel costs	0.1	0.1
Operation of installations	0.1	0.1
Total, MECA	$1.6	$2.1
Total, nuclear electric systems	$89.8	$41.1
Electronics systems		
Supporting research & technology		
Guidance	$5.0	$4.5
Control	4.9	3.5
Communication	4.6	4.8
Tracking & data acquisition	3.8	1.9
Instrumentation	4.3	2.7
Data handling	3.5	2.2
Personnel costs	18.4	13.8
Operation of installations	9.8	7.7
Total, supporting research	$54.0	$40.4
Project RAM		
Spacecraft	$3.0	$1.8
Scanner	1.8	
Orientation, control system		0.1
Personnel costs	0.7	1.7
Operation of installations	0.3	0.9
Total, RAM	$4.7	$4.5
Total, electronics systems	$59.4	$44.9
Chemical propulsion		
Supporting research & technology		
Analysis aerothermochemistry, materials	$7.5	$5.5
High energy propellants	3.3	2.8
Advanced vehicle engine technology	4.5	1.6
Advanced spacecraft engine technology	5.4	4.0
Experimental fluorine engine	1.6	0.3
Personnel costs	8.5	7.3
Operation of installations	4.0	3.4
Total, chemical propulsion	$35.1	$24.9
Space power		
Supporting research & technology		
Solar cells	$4.4	$2.4
Thermionic converters	4.0	2.5
Solar engine technology	3.1	4.1
Batteries & fuel cells	2.5	2.1
Chemical engines	1.9	0.5
Thermoelectric MHD advanced concepts	1.4	1.2
Personnel costs	5.9	5.1
Operation of installations	2.7	2.3
Total, space power	$25.2	$14.3
Human factors		
Supporting research & technology		
Life support & protective systems	$4.4	$4.5
Man-system integration	5.0	4.5
Human research & performance	4.9	2.5
Advanced concepts	0.9	0.8
Personnel costs	5.6	2.5
Operation of installations	2.6	1.5
Total, human factors	$24.4	$14.9
Totals, advanced research		
Research & operations	$564.0	$342.8
Construction	74.9	95.4
	$638.9	$437.0
Tracking, data acquisition		
Research activities		
Supporting research & technology		
System improvements	$11.5	$8.7
New system development	3.5	2.2
Integrated systems	2.0	1.7
Personnel costs	2.5	2.0
Operation of installations	2.2	1.8
Total, supporting research	$21.8	$16.4
Networks		
Operations		
Satellite net	$17.0	$11.7
Manned flight net	24.0	16.3
Deep space net	10.0	7.9
Launch area	5.0	3.9
Communications	14.0	10.0
Data processing, handling	7.7	4.4
Aerodynamics test range	0.8	0.5
Personnel costs	12.7	10.0
Operation of installations	12.4	10.1
Total, operations	$105.3	$75.0
Equipment components		
Satellite net	$22.0	$10.6
Manned flight net	84.0	42.7
Satellite net	22.0	10.5
Deep space net	10.0	7.5
Launch area	5.0	1.4
Data processing, handling	10.0	2.7
Communications	4.0	2.2
Aerodynamic test range	1.0	0.7
Total, new equipment	$134.0	$47.7
Total tracking, data acquisition		
research	$21.8	$16.4
networks	239.8	145.5
	$261.8	$159.7
Applications		
Weather satellites, rockets		
Nimbus		
Spacecraft & subsystems	$31.6	$21.3
Thor Atlas Agena vehicle	8.2	4.4
Data acquisition	4.1	4.5
Personnel costs	1.4	1.0
Operation of installations	1.7	1.2
Total, Nimbus	$46.9	$32.5
Tiros		
Spacecraft & subsystems	$2.0	$5.5
Data acquisition utilization	2.8	5.5
Thor Delta vehicles	2.4	10.2
Personnel costs	1.4	1.2
Operation of installations	1.8	1.4
Total, Tiros	$10.8	$23.8
Sounding rockets		
45 large rockets	$0.4	$0.2
100 small rockets	0.7	0.3
Experiments & support	1.4	0.8
Personnel costs	0.4	0.4
Operation of installations	0.4	0.4
Total, rockets	$3.3	$2.1
Supporting research & technology		
Synchronous satellite	$1.8	$0.5
Advanced sensors	5.2	1.0
Systems research	2.5	1.7
Component development	2.8	1.5
Personnel costs	1.1	0.7
Operation of installations	1.0	0.7
Total, supporting research	$12.5	$5.9
Total, weather satellites	$73.1	$64.3
Communications satellites		
Advanced synchronous satellite		
Spacecraft	$18.8	$2.3
4 Atlas Agena vehicles	13.5	2.2
Ground station equipment	5.0	1.1
Range range rate equipment	2.0	
Data reduction analysis	1.0	
Reliability studies	0.5	
Switching circuit	0.3	
Telemetry & command stations	0.6	
Services	0.5	
Operations	1.0	
Personnel costs	0.8	
Operation of installations	0.8	
Total, synchronous satellites	$41.1	$5.4
Syncom		
Spacecraft & components	$0.5	$3.7
3 Thor Delta vehicles		5.0
Range & range rate equipment	0.4	0.8
Rockets		0.4
Data reduction analysis	0.9	0.8
Test & ground support	2.9	3.6
Personnel costs	0.2	0.4
Operation of installations	0.3	0.4
Total, syncom	$4.8	$15.3
Relay		
Spacecraft	$	$3.0
Ground operations	1.7	8.0
Data reduction analysis	0.2	0.5
3 Thor Delta vehicles (funded in FY61)		
Personnel costs	0.3	0.5
Operation of installations	0.4	0.5
Total, relay	$2.5	$10.3
Echo 2		
Spacecraft & tests	$	$1.0
Data reduction	0.2	0.5
Thor Agena vehicle funded in FY62		
Personnel costs	0.4	0.8
Operation of installations	0.4	0.5
Total, Echo 2	$1.0	$2.8
Supporting research & technology		
Advanced synchronous satellites	$	$5.0
High gain structures	0.2	0.5
Passive satellites	1.2	2.8
Intermediate altitude satellites	2.0	2.0
Electronically steerable antennas	0.1	0.2
Isotope power supplies	0.2	0.1
Technical studies	1.3	2.4
Personnel costs	0.7	1.1
Operation of installations	0.8	7.2
Total, supporting research	$6.5	$15.2
Total, communication satellites	$55.8	$49.8
Advanced applications satellites		
Navigation and data collection systems		
Research	$1.0	$0.8
Personnel costs	0.2	0.1
Operation of installations	0.4	0.1
Total, advanced applications	$1.6	$1.0
Industrial applications		
Identification & documentation		
Research	$3.5	$3.4
Personnel costs	1.2	0.7
Operation of installations	1.4	0.7
Total, industrial applications	$6.1	$4.8
Total, applications		
research and operations	$136.8	$118.1
construction	4.0	
	$140.8	$118.1
Aeronautics		
Projects		
X-15		
Aerodynamics	$4.1	$
Loads & structures	0.1	0.1
Propulsion		
Operating problems	0.7	5.5
Personnel costs	3.3	4.4
Operation of installations	3.5	1.5
Total, X-15	$6.7	$10.4
Supersonic transport		
Aerodynamics	$0.7	$0.5
Loads & structures	0.8	0.9
Propulsion	1.3	0.4
Operating problems	1.2	2.5
Personnel costs	4.8	3.2
Operation of installations	1.8	1.0
Total, supersonic transport	$9.2	$9.1
V/STOL Aircraft		
Aerodynamics	$0.8	$0.8
Loads & structures	0.1	
Propulsion	0.2	0.1
Operating problems	0.8	0.3
Personnel costs	2.2	2.0
Operation of installations	1.1	1.0
Total, V/STOL aircraft	$4.9	$4.1
Supporting research & technology		
Aircraft & hypersonic cruise vehicles		
Aerodynamics	$1.9	$0.9
Loads & structures	2.5	1.6
Operating problems	2.5	3.0
Air-breathing propulsion	5.0	1.7
Personnel costs	9.9	8.8
Operation of installations	4.5	4.4
Total, supporting research	$24.3	$20.4
Total, aeronautics		
Research & development	$45.1	$44.0
Construction	3.3	8.7
	$48.4	$50.7

Turboprop YAT-28E Makes First Flight

YAT-28E, turboprop version of North American Aviation T-28 trainer designed for counter-insurgency operations (AW Feb. 4, p. 27), made a successful one-hour first flight Feb. 15 at the company's Columbus (Ohio) Div. George W. Hoskins, chief test pilot for the division, was at the controls. Aircraft can carry a load of heavy bombs, detachable .50-cal. machine gun pods and wing-tip mounted Sidewinder air-to-air missiles. Following flight tests by NAA, the plane will be turned over to USAF for additional testing and evaluation.

Sen. Case Seeks Watchdog Unit For Military, Space Contracts

Washington—Sen. Clifford P. Case (R., N.J.) plans to introduce this week a bill requiring fuller disclosure of defense contract information, including justification for awards, and establishment of a House-Senate committee to review military and space negotiated contracts.

"There is clearly a growing feeling that considerations other than actual requirements and absolute economy are entering into the selections of successful bidders on contracts," Sen. Case said. Campaign statements and press reports "tend to confirm this feeling that politics, influence and other extraneous considerations are involved in the selection of contractors."

Sen. Case—a member of the Armed Services, Appropriations and Aeronautics and Space Sciences committees—said his bill will be designed to require:

- Public record of all ex parte communications, written or oral, regarding defense and space contracts.
- "Full and complete public disclosure of the basis on which a negotiated contract award is made," except for classified information.
- Joint watchdog committee consisting of one Democrat and one Republican from each of these four committees: armed services, appropriations, government operations and space. The joint committee would have a permanent staff.

Although he did not include it in the bill, Sen. Case said he would press for tightening of the 1946 act regulating lobbyists so that contractors' representatives would have to register. "The enormous number of people that are constantly in the Pentagon from our greatest contractors and all over Washington, now ought, I think, to be registered as lobbyists," he said. "And there's nothing wrong with lobbying so long as the facts—their interests and what they're doing—are known." Several bills to reform the lobbying act have been introduced in past years, but none has been enacted.

The senator said he was especially disturbed about these recent negotiated contract awards:

- F-111 (TFX). Contract went to a team of General Dynamics and Grumman rather than Boeing. Investigating committee headed by Sen. John L. McClellan (D., Ark.) is trying to find out whether the award was technically justified or whether political pressure dictated the choice (AW Feb. 18, p. 25). Sen. Case said the award reversed the decision of evaluation panels.
- Mohole project. Brown & Root, Inc., of Houston, Tex., has been selected to plan and manage this project, in which deep hole will be drilled in the ocean floor to help determine the composition of the inner earth. No specific amount has been set on the contract, but the National Science Foundation, in announcing the award, estimated it would run between $35 million and $50 million, while Sen. Case said it would cost $43.6 million over five years.

"One NSF panel," Sen. Case said, rated this firm third best in a field of three and another NSF panel rated four firms as better qualified." Brown & Root also was awarded one of the construction contracts for the National Aeronautics and Space Administration's Manned Spacecraft Center in Houston, Tex. Chairman Albert Thomas (D., Tex.) of the House space appropriations subcommittee pressed for locating the space center in Houston.

"The final decision in either or both these cases may have been completely sound," Sen. Case said. "But under present limited disclosure practices it is impossible for the public to judge. A full disclosure of all relevant facts would benefit everybody. An informed public opinion would exert irresistible weight in support of decisions which are soundly based and against those which are not."

Parallel ICBM Studies

Current status of USAF Ballistic Systems Div.'s advanced ICBM analysis (AW Jan. 21, p. 23) include these parallel study efforts:

- Early warning systems—North American Space and Information Systems Div. and Hughes Aircraft.
- Advanced packaging encapsulation techniques—Lockheed Missiles and Space Co. and General Dynamics/Astronautics.
- Large payloads—Martin Co. and Space Technology Laboratories.
- Radio inertial guidance—IBM and General Electric Co.
- Global ranging guidance—Arma and IBM.
- Dormant missile guidance—AC Spark Plug and Sperry Rand.

Command and control will be studied by a single contractor—Radio Corp. of America.

Study areas still requiring contractor selection include long-range (global) missiles, extended (global) deployment, and hardened mobility related to small ICBMs which may be conducted in house by BSD.

NASA Asks $800 Million for Construction

By Alfred P. Alibrando

Washington—Massive buildup of launch and support facilities for the Apollo manned lunar flight program is reflected in the record high $800 million the National Aeronautics and Space Administration is requesting for construction in Fiscal 1964.

Large-scale construction of facilities began in Fiscal 1962 when $358.1 million was appropriated. In Fiscal 1963, with construction under way at Manned Spacecraft Center in Houston and on new launch facilities at Cape Canaveral, $737.4 million was appropriated.

Present plant value of NASA properties is approximately $1.2 billion. If the $800 million requested for Fiscal 1964 is appropriated, NASA will receive more for facilities in two years than it and its predecessor did in the previous 45 years. Most of the money requested this year is for continuation of work started last year.

This is the center-by-center breakdown of construction funds requested for Fiscal 1964:

• **Launch Operations Center**—NASA is asking $312.8 million for construction of facilities at Cape Canaveral. This together with the $443.1 million spent or obligated in the two previous years represents an investment of more than three-quarters of a billion dollars over a three-year period.

Most of the $312.8 million requested for Fiscal 1964 will go into Saturn 5 launch complex No. 39 and Saturn 5 support facilities. For continuation of work on complex No. 39, NASA is asking $217.2 million and $9.3 million for work on Saturn 5 support facilities. These include a vertical assembly building, flight crew quarters, spacecraft support personnel quarters, medical dispensary, launch control center, spacecraft operations control room, engineering shop, instrumentation facility, launch pad crawler roadway, arming tower, and buildings for fuel storage, data processing and tracking equipment.

NASA has acquired or is buying 88,000 acres of land adjacent to the present 15,000 acres on which the Atlantic Missile Range complex is built. The Saturn 5 launch complex is being built on the land north of the Air Force controlled launch area. The Saturn 5 launch complex will be served by railroads and a barge channel.

• **Marshall Space Flight Center**—Next to launch facilities, booster development will require the largest funding in Fiscal 1964 for construction. NASA is requesting $111.6 million for the Mississippi Test Facility, which is operated by Marshall. Largest portion of the $111.6 million is for static test stands for Saturn 5 stages and for the Rocketdyne J-1 engine that will power these stages. A total of $35.9 million is sought for static test facilities for S-1C, the Saturn 5 first stage; $19.1 million for test facilities for the S-2 second stage and $9 million for an F-1 stand.

Budget request for Marshall totals $38.4 million, the largest item being $5 million for utility installations. Most of the money requested is for additions to or expansion of existing facilities, or for continuation of improvements already under way.

Marshall also has responsibility for the Michoud plant, where the first stage of the Saturn 5 will be assembled. NASA is requesting $10.8 million for Michoud, $6 million of it for additions to existing production facilities.

• **Manned Spacecraft Center**—NASA received $112 million in Fiscal 1962 and 1963 for construction of facilities at the Manned Spacecraft Center. In addition, about $21 million was reprogramed from other funds this year for construction of a Mission Control Center. NASA said it pushed the control center ahead of schedule so it would be ready for Gemini flights in 1964.

Of the $37.7 million requested in the Fiscal 1964 budget, $8.4 million is for the Mission Control Center, $7.4 million for environmental and antenna test facilities, $6 million for a spacecraft control technology laboratory, $5 million for shops and other support facilities, $2.9 million for an atmosphere re-entry materials and structures evaluation facility, $2.6 million for an ultra high vacuum space chamber, and $2.2 million for a mission simulation and training facility.

Heavy funding of construction at the Manned Spacecraft Center will end with this year's request.

• **Lewis Research Center**—Total construction request is $25.8 million, most of it for alterations, improvement and additions to the existing plant at Cleveland. New facilities requested are a zero gravity chamber, $2.6 million; Snap 8 assembly and spacecraft checkout building, $5 million; propulsion component evaluation facility, $1 million; and propellant flow facility, $1.3 million.

Facility for testing for Snap 8 power source will contain liquid metal systems, a white room, nuclear materials storage, health room, instrument shops and cold soak equipment. The 30-kw Snap 8 power source is scheduled to fly in 1967. NASA points out that the cost of the ground test equipment, including the building, will be much less than the cost of the flight program. Cost of Saturn boosters, a single item, will run more than $25 million.

• **Goddard Space Flight Center**—Ten buildings have been completed, 10 buildings or facilities are under construction and four facilities are proposed in the Fiscal 1964 budget estimates.

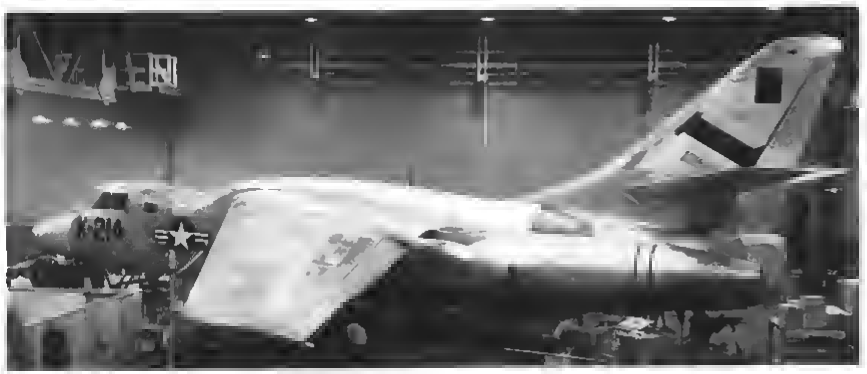
The $20.9 million Goddard construc-

NASA Construction Funding Breakdown

(millions of dollars)

Location	Plant Value	FY64	FY63
Launch Operations Center	$ 69.2	$312.0	$326.0
Mississippi Test Facility	(1)	111.6	73.2
Marshall Space Flight Center	142.4(1)	38.4	43.5
Manned Spacecraft Center	16.1(2)	37.7	45.2
Lewis Research Center	189.6	25.8	43.4
Goddard Space Flight Center	6[illegible]	20.9	17.5
Nuclear Rocket Development Station	56.0(3)	20.4	17.4
Ames Research Center	138.5	13.0	14.2
Michoud Plant	(1)	10.8	18.2
Langley Research Center	240.6	9.7	8.8
Jet Propulsion Laboratory	57.6	7.0	10.0
Flight Research Center	11.5	4.0	1.6
Wallops Station	52.1	2.0	4.1
Tracking stations and other construction outside of centers	200.0	176.0	99.0
Totals (4)	$1,200.0	$800.0	$737.0

(1) Plant value of the Marshall Space Flight Center includes Michoud and Mississippi Test Facility.
(2) Manned Spacecraft Center is still under construction.
(3) Value of Nuclear Rocket Development Station represents plant built with AEC funds.
(4) Some minor items were omitted from tabulation and totals are approximate.



Ground Vibration Tests Conducted on First X-21

First of two USAF/Northrop X-21 laminar flow control demonstration aircraft (AW Feb. 11, p. 80) has undergone vibration testing at the company's Norair Div., Hawthorne, Calif., prior to rollout and first flight. Compressor pod under each wing contains high and low pressure unit to draw air from wing boundary layer through spanwise slots in the wing, thus reducing friction drag on the aircraft.

tion request includes $5.3 million for a data interpretation laboratory, $5.7 million for a mechanical test and quality assurance laboratory, $4.1 million for a meteorological systems laboratory, and $800,000 for an isolated hazardous test facility.

Data interpretation laboratory proposed by Goddard would bring into one building about 400 persons now working at several locations at the center and in rented space elsewhere. The new building would provide an integrated operation for data analysis and processing, development of advanced data gathering, telemetry and control systems.

Mechanical test and quality assurance laboratory proposal includes a cylindrical 40-ft.-dia. test chamber 30 ft. high. This facility would provide a capability for performing mechanical tests in a vacuum and for testing competitive components.

Meteorological systems laboratory would bring together about 350 persons now working in widely scattered locations. It would centralize research work on the structure, composition, motion and dynamics of planetary atmospheres, experiments in the physics of atmospheric gases and study of data-handling for weather reporting on a global scale.

The laboratory also would become a center for development of new or improved experiments for flight aboard sounding rockets, satellites and probes and for design and development of advanced spacecraft electronic systems.

Isolated hazardous test facility would be used for tests on explosive devices, such as explosive bolts, squibs and primer cord, and for experiments involving radioactivity or electromagnetic radiation.

• **Nuclear Rocket Development** Station—Request for new construction and additions or improvements at the Nevada station totals $20.4 million. Included are $6.7 million for additions to test stands, and $9.5 million for additions to existing support facilities and construction of new support facilities.

One of the major new buildings proposed is a radioactive materials handling, storage and decontamination facility for storing spent fuel, entire or partial reactor cores and highly radioactive engine components. It will also have an area known as the hot engine build area, where an engine can be moved to prevent prolonged exposure of test stands and their associated components to radiation.

• **Ames Research Center**—Largest item in the $13.0 million construction request—one that may encounter some opposition in Congress—is $4.8 million for a life sciences laboratory. The new building would house 300 scientists and support personnel.

Life sciences laboratory is to provide space for work in three general areas: biotechnology, research, biomedical research and exobiology—the search for extraterrestrial life.

There has been some resistance in the House and Senate space committees to NASA's plans for separate life sciences laboratory facilities. Opposition is based on the Air Force's capability to do work similar to that proposed by NASA. The agency has argued that it has the responsibility for life sciences research without the in-house facilities for carrying it out.

Ames' request also includes $3.6 million for a spacecraft materials laboratory for studying the effects on spacecraft materials of high vacuums, electromagnetic and particle radiation, re-entry heat and micrometeoroid impacts.

Proposed satellite attitude control system test facility would cost an estimated $1.2 million. It would be designed to simulate operation of attitude control systems in the space environment. The facility is primarily a vacuum chamber in which light sources will simulate the earth, stars, sun and moon to accommodate control sensors. The system will simulate the flight of a spacecraft through the placement of the control system on a platform supported by a gas bearing.

Remaining major item is $1.6 million for a structural dynamics laboratory. Ames is requesting this facility for pre-test calibration and checkout of models involved in dynamic tests. The center said it wants to extend the scope of work it is doing in transonic buffeting of launch vehicles, the dynamics of liquid and solid fuels and lunar landings.

• **Langley Research Center**—New facilities requested are modest compared with some of the programs under way at other NASA centers. Total proposed outlay for Fiscal 1964 is $9.7 million. New facilities requested are an electronic instrumentation laboratory, $2.9 million, hot gas radiation research facility, $2.6 million and a fatigue research laboratory, $1.2 million.

The electronic instrumentation laboratory would provide facilities for research in microelectronics, development of thin film components and advanced research and development of measurement devices and techniques.

Research on the effects of high heat, vibration and aerodynamic stresses will be centralized in the proposed fatigue laboratory. Much of the equipment to be used is on hand now in hangar-type buildings originally intended for calibration of aircraft for flight tests.

Hot gas radiation facility will consist primarily of a 6-in. dia., 45-ft. long shock tube. Using models of spacecraft configurations, the shock tube will simulate thermal radiation conditions from the hot gas cap that envelops spacecraft on entry into atmosphere.

• **Jet Propulsion Laboratory**—Largest item in the $7 million JPL construction request is $3.9 million for an engineering building. Engineering development activities housed in trailers at the Pasadena research center and in rented space would be centralized.

• **Flight Research Center**—NASA is asking for $4 million to build a flight research support laboratory and high temperature loads calibration facility at the Flight Research Center, Edwards, Calif. The proposed laboratory would house simulators and supporting analog and power supply equipment. The high temperature loads facility would be used to provide the environment for calibration of high performance aircraft and spacecraft for flight measurements.

• **Wallops Station**—NASA is requesting $2 million for construction of beach protection between the Atlantic Ocean and launch pads at Wallops Island, Va. The request also includes funds for a general purpose sounding rocket launch complex, a universal launcher, retractable shelters for existing launchers.

Requests other than those for NASA centers total $176 million and include:

• **Three tracking and instrumentation ships**, $90 million. The ships will be obtained from the Maritime Commission's reserve fleet and will be equipped with precise inertial navigation and ship data correction systems. The ships are to be ready for tracking duties in early Apollo missions scheduled for late 1965. Their tracking, data acquisition and communication equipment will include C-band radar, S-band Doppler, a central high-speed digital computer to determine orbital elements, command transmitting systems and teletype, voice and high-speed data links with the manned flight tracking network and Mission Control Center.

• **Facilities for development** of the Aerojet-General M-1 engine, $16 million. These funds are to be used for equipment and facilities at Aerojet General's plant near Sacramento, Calif. The M-1 is a 1.2 million-lb. thrust hydrogen engine, being developed for the Nova upper stage.

• **Lunar Excursion Module** test facility, $15 million. A combined propulsion and flight test facility is to be built at the White Sands Missile Range.

• **Estimated cost of completing** facilities for testing of the F-1 Rocketdyne engine is $14.2 million for three static test stands at Edwards, Calif., and development facilities at Canoga Park and Santa Susana, Calif.

Industry Contractor Planned for Ranger

National Aeronautics and Space Administration plans to select an industry contractor to build the Ranger spacecraft for future launches. Jet Propulsion Laboratory, which has been conducting the program as an in-house effort, will continue as program technical manager. The action is reported to have had the approval of NASA Administrator James E. Webb, Deputy Administrator Hugh L. Dryden, and Associate Administrator Robert C. Seamans, Jr.

Specific vehicle in the Ranger series to which this program reorientation will apply will depend on the speed with which a contractor is chosen. NASA program officials favor initiation of a competition to select a contractor, but a sole-source award may be made to expedite the program, which is aimed at TV surveillance of the moon in preparation for the Apollo lunar landing. Assumption is that JPL's present Ranger subcontractors will be retained under the new manufacturing plan, since selection of new subcontractors would delay the program.

Several companies have discussed the possibility of providing the manufacturing services for building Ranger spacecraft with NASA. Selection of one of these without competitive bidding would be a joint decision of NASA and JPL. Two contractors seen favored for the manufacturing task if a sole-source award is made are Northrop's Nortronics Div. and General Electric's Missile and Space Vehicles Div.

Intention is to funnel 10 Ranger spacecraft into the manufacturing effort initially. Ranger 6 now is scheduled to undergo a destructive testing cycle at JPL to determine possible engineering design refinements for incorporation in Rangers 7 through 9 (AW Feb. 18, p. 33). First of the spacecraft to be built by the industry contractor therefore would have to begin with Ranger 7 or one later in the series. Observers close to the situation feel that it certainly will be introduced before Ranger 10, which had been scheduled to be launched in the last quarter of this year.

JPL had proposed to NASA, as late as a year ago, that at an appropriate time an industry contractor be given the task of building the Ranger spacecraft. NASA's intention, however, to implement action at this time probably was influenced by the recent findings of an official inquiry board headed by Dr. Albert Kelley (AW Dec. 17, p. 33 and Dec. 24, p. 17) which convened after the fifth successive Ranger failure and was critical of quality control, engineering design, and test procedures.

JPL Receives Mars Radar Signal Echoes

Pasadena, Calif.—Jet Propulsion Laboratory has successfully received echoes of radar signals which it is bouncing off Mars in continuing experiments to learn more about that planet.

The approximately 125-million mile round-trip path is the longest known to have been covered by signals generated in the Western world.

Preliminary analysis of signal echoes received at the Goldstone station of the Deep Space Instrumentation Facility (DSIF) indicate that Mars has smooth and rough areas much like the earth and moon and that the neighboring planet is a better radar reflector than the moon, but not as good as Venus.

Beginning Jan. 21, the experiments will be continued through early March, when the earth moves out of Mars' range, overlapping the date of inferior conjunction (Feb. 2) when the two planets were at their closest proximity.

It may now be possible for JPL scientists to confirm data on the slow retrograde motion of the planet Venus, obtained in a somewhat similar radar bounce experiment late last year (AW Jan. 7, p. 31). This might be accomplished by comparing returns from Mars, whose rate of rotation is precisely known from astronomical calculations, with those from Venus.

To the Mars experiment, S-band signals at 2,388 mc. were radiated by a newly installed 100-kw. transmitter located at Goldstone and concentrated by an 85-ft. parabolic antenna into an 0.3-deg.-wide beam with an effective radiated power of 2.5 billion watts.

About one watt of this is intercepted by Mars, and about 5% of this reflected toward the earth. By the time the signal is again picked up by the same 85-ft. dish, effective power is only 10^{-26} w.

Total time required to cover the transmission path during inferior conjunction was 11.1 min.

Signals transmitted were of two types—continuous wave signal transmitted for 11 min. and then interrupted to permit reception, and a signal with a pseudo-random modulation. The experiment is being conducted nightly for a 12-hr. period while the two planets are in view of each other.

Reflected signals are analyzed for strength and the manner in which they are smeared or distorted, which provide clues about the planet's rate of rotation, roughness and material. A rapidly rotating planet like Mars would tend to smear the echoes.

Preliminary analysis indicates signal strength that Mars reflects to be 2 to 20% of the signal that could be expected if the planet were a perfectly conducting sphere.

Navy Calls Manned Aircraft 'Indispensable'

By George C Wilson

Washington – Navy is concerned about the reduced procurement of aircraft because the service considers manned aircraft indispensable for the foreseeable future to control the seas and support the armed forces, Adm George W Anderson, chief of naval operations, told the House Armed Services Committee last week.

He called the new Navy aircraft "among the finest in the world" but said "then increased capabilities do not necessarily compensate for the numbers which, by our experience, we know are required to fulfill our assigned responsibilities."

Navy must have enough aircraft to survive the heavy losses which would be sustained in the early phases of a war, Adm Anderson said. It is asking for $1.96 billion in new obligational authority for Fiscal 1964 to procure 681 aircraft compared with $2.1 billion for 887 aircraft in Fiscal 1963.

Adm Anderson testifying against the backdrop of congressional concern about the phasing out of the Air Force's manned bombers, said the requested Navy aircraft "are urgently required to enable our fleets to fulfill their missions . . . For naval purposes, the manned aircraft is indispensable for the foreseeable future and has not decreased in its importance." He and other Navy officials then gave the committee these details about the service's aircraft and missile programs for Fiscal 1964:

Procurement

• **Fixed-wing aircraft.** Navy in Fiscal 1964 intends to buy Douglas A-4E Skyhawk, Grumman A-6A Intruder, North American A-5C Vigilante, McDonnell RF-4B Phantom 2 for the Marine Corps and F-4B for the Navy, Grumman E-2A Hawkeye, Grumman S-2E Tracker, Lockheed P-3A Orion turboprop patrol bomber, Lockheed C-130F transport to support Polaris submarines, and three trainers—Beech L-23F, North American T2J-2 and the Grumman TC-4B turboprop navigation trainer.

Vice Adm William A. Schoech, deputy chief of naval operations for air, said the A-5C version of the Vigilante, with its reconnaissance and attack capability, will help remove "the serious Navy deficiency" in the field of "timely and adequate" intelligence information for fleet commanders.

• **Helicopters.** Navy will buy for the Marines the Boeing-Vertol CH-46A Sea Knight and Bell UH-1E. The UH-1E will replace existing Marine observation aircraft—the Cessna P-1B and Kaman PH-43D helicopter. Navy will buy the Sikorski SH-3A Sea King for anti-submarine missions, Kaman UH-2B all-weather helicopters for search and rescue, and the Sikorsky CH-53A modified Flying Crane to support assault forces.

Research and Development

Navy is requesting $1.573 billion in new obligational authority for its research and development program. Of that amount, $204 million would go for aircraft and $590 million for missiles. Highlights of the Fiscal 1964 research program:

• **General Dynamics/Grumman F-111B (TFX).** Vice Adm. William F. Raborn, deputy chief of naval operations for development, said the aircraft's "primary armament" will be long range air-to-air missiles advanced enough to deal with enemy aircraft of the 1970 time period. Missile system is being developed by the Navy.

• **Grumman C-2A.** Adm. Raborn said the role of this carrier onboard delivery (COD) aircraft will be to carry cargo such as aircraft engines to and from aircraft carriers at twice the range and three times the payload capacity of present COD aircraft (AW Feb. 18, p. 27). First C-2As will join the fleet in Fiscal 1964, he said.

• **McDonnell F4B equipment.** Improvement effort will center on developing downward-looking radar which would show enemy aircraft flying at low altitudes. "Improvement in low-altitude intercept capability is urgently needed by the Navy, Marine Corps and Air Force," Adm. Raborn said.

• **Grumman E-2A radar.** Effort will concentrate on improving this turboprop aircraft's radar so it can detect low-flying aircraft approaching from sea or land (see p. 30).

• **Advanced turboprop.** Navy will continue working on a next-generation turboprop engine which will be fed by air pre-heated by exhaust gases. Adm. Raborn said such an aircraft engine would provide the fuel economy needed by anti-submarine aircraft for long endurance at partial power. Loitering time could be more than doubled by using this type of engine, he said, and the improvements could be built into existing aircraft such as the Lockheed P-3A Orion.

• **ASW equipment.** Adm. Raborn said a substantial effort would be made to develop an advanced anti-submarine warfare avionics system which would integrate subsystems on airborne detection equipment. Objective will be to simplify the system so it will be easier to operate. A related program is designed to develop electronic equipment to intercept signals from enemy submarines and to perfect both jamming and anti-jamming devices.

• **Exploratory projects.** These will include new ASW radar, new generation of sonar equipment capable of detecting submarines lying beneath the thermal layers of the sea and magnetic anomaly detection (MAD) equipment for anti-submarine use.

Navy Missiles

Navy missile program is largely a continuation of current development projects. But effort on the Bendix-McDonnell Typhon surface-to-air missile will be decreased in Fiscal 1964. Adm. Raborn said a re-appraisal of this "radically advanced guided missile program" has led to the decision to switch to a "more conservative program that will insure that technical problems will be defined and solved in a step-by-step basis."

He said the auxiliary ship Norton Sound will be converted into a testbed for the prototype Typhon system in problems can be solved before it is put on a combat ship. "Good technical judgment has dictated this type of approach," Adm. Raborn said.

Other details of the Navy's Fiscal 1964 R&D program:

• **Goodyear Subroc.** Navy plans to complete laboratory environmental and reliability tests on this submarine rocket missile (AW Feb. 18, p. 19 cover).

• **F-111B missiles.** Adm. Raborn said Fiscal 1964 funds would be used for wind tunnel tests for the aircraft's long range air-to-air missile, missile system mock-ups, installation of airborne missile control system prototypes in instrumented aircraft. He said the aircraft and missile system would be compatible with the Continental Air Defense System command and control system.

• **Raytheon Sparrow 3.** Fiscal 1964 funds will be used to apply the improvements in the F-4B+ radar to the Sparrow air-to-air missile weapon system.

• **Martin Bullpup.** Navy intends in Fiscal 1964 to complete Bullpup B's development, continue the qualification of the liquid rocket motor and complete the testing of the Grumman A-6A all-weather system.

• **General Dynamics Tartar.** Performance evaluation will continue, new warheads will be completed and the surface-to-surface capability of this original surface-to-air missile will be tested. Same type of conversion will be used on the General Dynamics Terrier and Bendix Talos surface-to-air missiles.

• **Sea Mauler.** This program will attempt to adapt the Army-General Dynamics Mauler missile—designed for use against tanks and other armored vehicles—for use on small ships. Navy said the Sea Mauler would have its own acquisition and tracking radar, computer and launching equipment.

The weapon would be used in anti-submarine and amphibious warfare.

Anderson Sees No ASW Solution Soon

Washington—Navy considers anti-submarine warfare its most crucial problem and sees little hope in the near future for a technological breakthrough that will enable the service to counter the Russian submarine threat.

Adm. George W. Anderson, chief of Naval Operations, gave this assessment to the House Armed Services Committee, which is continuing its military posture hearings this week. He said the Navy's operations during the Cuban crisis tested anti-submarine warfare capability and "the results were highly gratifying."

But he said there is "no particular development on the horizon which would permit us to place upon our ships and in our aircraft black boxes which would enable us immediately to detect, locate, identify and destroy enemy submarines. . . . Anti-submarine warfare continues to be and most certainly will be in the years to come, our most crucial problem."

Navy made 20 contacts with submarines during the Cuban crisis, he said, and identified six as being Soviet through photographs. He said the Soviet submarines identified were conventional types, not nuclear-powered.

The Russians have improved the quality of their ships, their techniques and the abilities of their personnel to operate submarines," Adm. Anderson said. "Therefore our efforts cannot be slackened. . . . We must continue to take fullest advantage of all industry and science have to offer and to make whatever expenditures of funds may be considered advisable if some sudden breakthrough should present itself. I devoutly hope one does, but none is now in sight."

Von Karman Awarded First Medal of Science

First National Medal of Science was awarded to Dr. Theodore von Karman last week by President John F. Kennedy for "incomparable contributions not only to the fields of applied mechanics, aerodynamics and astronautics and to education in general but also to industrial, national, international and human affairs in their broadest sense." Von Karman, now chairman of the technical advisory board of Aerojet-General Corp. and chairman of the NATO Advisory Group for Aeronautical Research and Development, was director of California Institute of Technology's Guggenheim Aeronautical Laboratories from 1930 to 1949. Left to right: Gen. Bernard A. Schriever, commander of Air Force Systems Command; the President; Judge Victor Anfuso, former Democratic congressman from New York; Dr. von Karman; USAF Chief of Staff Gen. Curtis LeMay; Lyman Briggs, president of Caltech; William J. Zisch, president of Aerojet-General.

Mars 1 Communication

Moscow—Soviet Union continued to maintain radio contact with its Mars 1 probe on Feb. 19 when it had reached a distance of 38.5 million mi. from earth, according to the Soviet news agency Tass. It was the greatest distance in space communications the Russians have yet obtained. U.S. had contact with the Mariner 2 Venus probe for 54.3 million mi. Tass also reported that Mars 1 confirmed the existence of a third radiation belt at a distance of 6,200 mi., and that this belt contains more charged particles than those closer to earth.

News Digest

General Electric last week delivered the first Gemini operating fuel cell power unit to McDonnell Aircraft Corp., prime Gemini contractor.

United Aircraft Corp. will build a multi-million dollar company-financed facility at its Pratt & Whitney Florida Research and Development Center for the testing of all known combinations of liquid rocket propellants including fluorine, hydrazine, diborane and hydrogen at chamber pressures up to 5,000 psi and thrusts up to 50,000 lb. Work is to begin next month and the facility is to be operational by fall.

Milton W. Rosen resigned Feb. 21 as director of launch vehicles in the NASA manned space flight office and will become assistant to Adm. W. L. Boone, assistant NASA administrator for defense affairs.

First firing in the 120-in.-dia. solid-propellant motor development program for Titan 3-C was scheduled to be conducted last week at United Technology Center's Coyote Test Facility near Simi Valley, Calif. The single 10-ft.-long segment test motor was programed to burn for about 105 sec. and produce a thrust of approximately 200,000 lb.

Four-stage Blue Scout which using Lockheed Propulsion Co. MG-18 high-mass fraction motor as its top stage was launched last week from Pt. Arguello, Calif., to put a satellite into south-south orbit. This is the first orbital exercise in a series of launches in Program 35 conducted by USAF Space Systems Div. for the Office of Aerospace Research in USAF headquarters.

Mitsubishi Shipbuilding and Engineering Co., Tokyo, will build the Westland SRN-1 hovercraft under a license agreement with Westland Aircraft Ltd. of Great Britain.

First definitive Apollo contract was signed by NASA last week with General Dynamics Convair for $63 million to produce four Little Joe 2s.

Zero-launch booster for the Lockheed F-104 Starfighter will be built by Ninth Aerospace Systems Solid Rocket Div., McGregor, Tex., under subcontract to Lockheed, which has a development contract from the West German government for the system. Booster is similar to the M-34 unit developed for zero-launch of the North American Aviation F-100 and Chance Vought RF-8U-1.

ALPA May Reject Pact With American

American's pilots and engineers agree on contract but ALPA maintains it does not meet union's standards.

By James R. Ashlock

New York—Air Line Pilots Assn. has threatened to refuse ratification of a contract proposed by its 1,850 American Airlines members in settlement of the three-man jet crew issue.

American's pilots and engineers have agreed on a pact, which has the company's blessing and is considered simpler than those adopted by other airlines in reducing crews from four to three men. But ALPA maintains it does not meet the requirements of the union's "fail safe" standards, and has told its American chapter that it is unacceptable.

"The union isn't giving us much choice,' one American pilot said. 'We think this agreement is best for all concerned, and we're going to stick by it. If ALPA expels us, we'll simply have to work out some other means of representation."

However, few sources close to the issue feel expulsion will result, especially since American's pilots contribute 15% of ALPA's dues.

ALPA Standards

Difference stems from American's crews feeling there is no need for flight engineers to obtain commercial and instrument ratings to qualify for pilot-engineer duties. But these ratings were keys to the ALPA standards drawn up when the union agreed to a reduction in jet crew complement.

Trans World Airlines, Pan American World Airways, Eastern Air Lines and National Airlines all implemented the ALPA requirements in their pilot training for flight engineers, at a cost of about $10 million per airline. However, it was specified in the contracts that despite such training, the pilot-engineer would never be permitted to fly jets.

American's crews for the most part share the view expressed by John Carroll, a TWA captain and one-time ALPA vice president.

"The TWA ALPA and TWA flight engineer agreements make a total farce of the ALPA crew complement policy,' Carroll said. "The agreement forbids the third crewman to fly the aircraft. A new riddle has arisen: the question being, 'when is a pilot not a pilot?' The answer is, 'when he's the third man in an ALPA qualified fail-safe crew.'"

Opponents of the ALPA plan say that giving a man 180 hr. of flight training in light aircraft—which is sufficient for a commercial and instrument rating—doesn't make him a qualified jet crewman. In most instances, they say, the engineer merely tucks his ratings in his pocket and resumes his previous flight engineer duties, without ever undergoing jet transition training or even any recurrent refresher time in flight planes. Pilots emphasize that before a man can even be accepted by an airline for training as a pilot, he must have 1,500 hr. of flight time in addition to his commercial and instrument ratings.

American's crews feel that instead of pilot training, the engineers should be familiarized with radio work, navigation, chart reading and the processes of obtaining flight clearances. Thus they would be able to assist the two pilots in the busy periods at the beginning and end of each flight. These are also vital duties in the event that one of the two pilots should become incapacitated, and the flight engineer could still ensure the "fail-safe" principle by assisting the one man flying the aircraft.

"Our company, like all the others is adamant in refusing to let the pilot-engineer ever take control, and it should be," an American pilot said. 'So why go to the expense of giving him pilot training when he can be of more service in the respect we propose."

Under the American contract, classroom and flight simulator training for the 600 flight engineers would cost approximately $3½ million, saving the company about $6½ million. This saving would be passed on to the crews through adding benefits they are asking.

Main concession the pilots would gain would be a reduction in monthly flight time from the present 85 hr. to 75 hr. in jets and 80 hr. in pistoo aircraft. Company would also pay 75% of crew insurance premiums—an expense now borne by crewmen—and would pay the 7% of salary the individuals contribute monthly to their retirement fund. Duty rigs, money paid for non-flying time, would also be improved.

"This is the best contract worked out since this crew complement issue came up," one spokesman said, "and we arrived at it ourselves without a bunch of strike threats and prolonged federal mediation. But now ALPA is giving us trouble over this minor issue of the flight engineer's ratings."

American has also agreed to include "no furlough' and "no crew reduction' clauses in the contract. And because of the reduction in flight time, all but about 40-50 of the airline's 250 third pilots would immediately be needed as copilots. Rapid advancement of all other third pilots to full-time flight status, contract negotiators said, would result because of pilot attrition and American's jet expansion.

One basic ALPA problem, however, is that the union must maintain consideration of its members on other airlines who have signed agreements under the union's standards. Ratification of the American agreement could stir dissention among those who might ask why they too were not exempted from the ALPA requirements so as to negotiate simpler contracts, especially since the flight engineer wasn't to be allowed to fly anyway.

Union Strategy

American's pilots feel that ALPA's standards were a part of strategy aimed primarily at eliminating Flight Engineer International Assn. (FEIA) representation from the flight deck. But the FEIA is no longer as strong a union as it was when the standards were adopted, and many pilots in other airlines as well as American feel there is no need to continue such "craft elimination" tactics.

As a result of ALPA's stand, American's flight engineers have become uneasy about their agreement to shift to ALPA membership. They want assurance of some union representation before giving up their FEIA positions, and the threat of ALPA expulsion has caused a delay in the contract proceedings. However, American's pilots are confident this problem will be resolved to everyone's satisfaction.

Although rifts within its membership are nothing new to ALPA, there are indications of general disagreement with the union's practices. Numerous pilots complain that the membership has become too diversified with the advent of local service, non-scheduled, cargo and helicopter operations. The union, they say, has made no effective effort to separate these categories to centralize interests and goals.

Objections Expected on CAB Fare Rejection

Washington—Strong protests are expected against the Civil Aeronautics Board's rejection last week of an International Air Transport Assn. proposal to reduce round trip discounts from 10% to 5% for all Pacific service and Atlantic economy fares.

In a 3-2 decision, with Members Chan Gurney and Whitney Gillilland dissenting, the IATA resolution was rejected primarily on grounds that it would constitute an unnecessary 5% fare raise in view of U.S. flag carrier earnings over the trans-ocean routes.

IATA members are expected this week to file strong objections to the Board order, since the resolution carried the unanimous approval of all members and the tacit approval of the various foreign governments involved. Many of these airlines are expected to contend that while the Pacific and Atlantic routes have been profitable for U.S. carriers they have not been so for them.

Board sources indicate that if the foreign airlines are prepared to offer proof of their financial positions, CAB must reconsider the order and approve the IATA resolution for a temporary period.

However, they point out that the information needed has been sought unsuccessfully by the CAB in the past and that it is unlikely the foreign carriers will produce such evidence now.

Using traffic and financial data of the U.S. flags as the "only available yardstick," the Board noted that both Northwest Airlines and Pan American World Airways realized a rate of return on investment of nearly 14% for their Pacific services last year. Noting that a rate of 10.25% has been established as reasonable for domestic trunks, the Board concluded that the higher rate was "strong evidence" that a round trip fare increase would be unjustified in the Pacific.

The Board conceded that both Trans World Airlines and Pan American have experienced inadequate earnings over the Atlantic, but pointed out that their problem is excess seat capacity rather than inadequate fares. Increasing fares would not improve the airlines' falling load factors and would only add to the price paid by the passenger for empty seats, CAB said.

Rate of traffic growth over the route has usually exceeded 15%, and this, coupled with the airlines' near-completion of jet re-equipment, should result in higher load factors and profits in the future, the order said.

Comparing the high load factors of Pan American, Panagra and Braniff with their unusually low rates of return, CAB approved an IATA proposal for a 5% round trip fare increase in the South American market area.

Last year, Pan American realized only a 0.9% return on investment from its South American services, despite an average load factor of 63.8%. Citing similar disparities with the other carriers, CAB added that the increase is justified because of the lower average yield per passenger mile in the area.

Trunkline Financial Status Dispute Flares During Merger Hearings

Washington—Clash between smaller trunkline carriers and American and Eastern airlines over whether the industry is financially sick or healthy reached a climax last week in oral arguments before the Civil Aeronautics Board in the American-Eastern merger case.

Charging that Eastern and American are "prophets of doom" six carriers—Braniff Continental, Delta, National, Northeast and Northwest—consolidated forces in a single presentation before the Board aimed at proving that the industry is basically sound.

American Airlines' George A. Spater began the arguments with a warning that the domestic trunklines have experienced declining load factors since 1951, with earnings following the downward trend.

Spater said that load factors in 1962 were the worst in the 25-year history of the CAB, and January, 1963, load factors were four points below January, 1962 (AW Feb. 18, p. 42). He added that there has been a huge increase in total airline debt and debt-to-equity ratios since World War 2.

The heavy debt is caused by inadequate earnings since 1956, despite a period of general industrial prosperity, Spater said. Lawyers for the six smaller carriers admitted that not all carriers were earning fully adequate return on investment, but one of the lawyers added:

"However, we do contend that the substantial improvement in industry results which were achieved in 1962—and which are continuing in 1963—indicate a capacity for improvement within the present confines of our industry and without the violent restructuring which the applicants argue to be the only solution."

Original five carriers that opened the industry split late last year (AW Dec. 10, p. 38) were joined in the fight against the merger by Northeast Airlines. United, which merged with Capital Airlines in 1960, and TWA, a merger prospect with Pan American World Airways, have opposed the American-Eastern merger single. Only Western Air Lines has not participated in the case.

In its argument Eastern stressed the need for a merger as a means of arresting the deterioration in its financial position. In a projection of funds required and available during the 1963-1965 period, Eastern said it would suffer a total cash deficiency of $129 million.

Eastern said that it has estimated that the merger would result in a capital savings of $100.7 million and an expense savings of $54.7 million.

The carrier said that a main cause of its financial difficulties was the heavy competition placed against it in CAB route awards. It estimated that since 1955, competitive route awards to other carriers have drained more than $50 million from Eastern annually and have increased costs more than $60 million.

Referring to the smaller trunklines as the "favored five," Eastern said that the largest monopoly markets of this group are much larger than Eastern's noncompetitive markets in terms of revenue passenger miles.

In this connection, American charged that smaller airlines, sheltered from competition, have shown much better earnings than larger carriers and these better earnings have been reflected in airline stock prices.

The six small carriers attributed Eastern's recent losses in part to the 1960-61 recession. They added, however, that Eastern was caught by a series of unusual factors "each of which

Eastern Financial Status

Washington—Eastern Air Lines last week estimated its 1962 loss before taxes will amount to $36.3 million, and $20.7 million if Mutual Aid Pact payments are approved by the Civil Aeronautics Board.

In its oral argument before the CAB, Eastern indicated that as of Jan. 1, it had available working capital totaling $2 million, equivalent to only three days' cash needs. By contrast, the carrier said its working capital on hand on Jan. 1, 1960, was $43 million, a 63-day cash coverage.

Long-term debt on Jan. 1, 1963, totaled $150 million. Permissible borrowing under current loan agreement formulas stood on that date at $147.8 million, so that the airline estimates it has already exceeded its permissible borrowing by $2.1 million.

was directly tied to Eastern's peculiar managerial decisions and policies." These included strikes, efforts to overcome an "admittedly poor public image," and "uneconomic scheduling practices."

Harold Russell, counsel for Eastern, said that Eastern's early consistent earnings record gave rise to the impression that Eastern was indestructible, "with the result that an avalanche of competition was imposed 15 years ago and, before the effect of that competition could be evaluated, still further competition was imposed."

The result was that Eastern has been converted into a submarginal airline, steadily in the red for the past three years, with no prospects for improvement in its present framework, he said.

American set out to prove that the merged companies would have the same size relationship to most other airlines that American did in 1951. Spater said that in any case, the smaller carriers have often proclaimed their ability to compete with larger carriers when they were applying for routes competitive with larger airlines.

Spater said this claim was borne out by actual experience. He produced figures showing that in the 50 top markets the largest airline had the largest traffic share in only 12 cases and the smallest share in 15 cases.

The six small airlines declared that the merger would cause these problems:

- **Create an airline** with sufficient strength to overwhelm smaller competitors.
- **Create illegal monopolies** in major transport markets.
- **Violate sound** and long-established anti-trust policies.
- **Weaken the CAB's** policies toward attainment of a balanced competitive air route pattern.

The six carriers contended the industry will overcome the expansion problems resulting from the introduction of jet transports in large numbers and gave the following reasons for an improved outlook:

- **Jet transition** is substantially completed.
- **Industry has recovered** from the general business recession of 1960-61.
- **Federal Aviation Agency** forecasts a 52% increase in traffic by 1970, 82% by 1975.
- **Rate of return** on investments has started to climb upward.

Airlines Fear Tax Cut May Bring U.S. Airways User Charge System

By Robert H. Cook

Washington—Airline managements are concerned that adoption of an Administration-proposed cut in corporate taxes may rekindle congressional interest in a costly user charge system for the federal airways that would far exceed any future tax savings.

Most carriers employ an accelerated depreciation for tax purposes on their turbojet fleet. The Administration proposal would have the greatest impact at about the time this flight equipment is almost fully depreciated. If approved by Congress, the proposal would reduce corporate taxes from their present level of 52% to 47% by 1965, in steps of 2% next year and the balance in 1965.

Actual savings to the airlines under the tax reduction can only be estimated since industry financial accounting to the Civil Aeronautics Board is a matter of theoretical "book value" figures, as opposed to actual financial data reported by the carriers to the Treasury Dept. for tax purposes. But observers who have analyzed the tax situation doubt that the proposed reduction will provide any significant benefit to the industry.

Assuming that industry profits continue their slow upward trend, these observers explain a point will be reached where the airlines will have most of the present turbojet fleet fully written off at a time when profits may be higher than they are now. Large sums of revenue, previously channeled into depreciation reserves may then be channeled into net profit, increasing the amount subject to taxation.

Further diluting the benefits that a corporate tax cut would bring is the the fact that new Treasury Dept. depreciation guidelines are designed to force airlines to retire fully-depreciated equipment within a reasonable time, or face heavy taxes on depreciation funds.

In addition, the Administration proposal also classifies revenue from the sale of surplus aircraft as income subject to full corporate tax, as opposed to the present treatment as a capital gains, which requires a tax of only 25%. In 1961, the airline industry realized $8 million on the sale of surplus aircraft.

Net profit position of the industry will also be affected in the future by the full write-off of flight equipment. Under present tax laws the airlines have been allowed to accumulate a special deferred taxes fund, representing the difference in taxation as reported to the CAB and actual taxes paid.

Once this write-off is completed, the special provisions permitting this type of fund will no longer be applicable. Deferred tax reserves will then be applied to actual taxes, and while the tax rate may be lower than present, net effect will be to subject the industry to its first heavy taxation in years, observers contend.

Financially, the airlines welcome a tax cut, but psychologically they fear both the Administration and Congress may overestimate its cumulative value worth and consider it an adequate offset to increased user charges for the federal airways system.

Last year, Congress reduced the transportation tax for airline travel from 10% to 5%, but failed to act on an Administration proposal to increase taxes on gasoline by 2 cents, place a new 2-cent tax on turbojet fuel and levy an additional 5% tax on airfreight.

If a user charge system were adopted during this session of Congress, the heavy expense impact it would have on airline earnings would nullify the benefits of a tax cut, the airlines contend.

Last year, the scheduled carriers paid $110 million in federal taxes collected on the 5% transportation tax, plus $13 million in gasoline taxes. Increase of the gasoline tax, plus addition of the tax on jet fuel and freight shipments would bring the annual total to an estimated $184 million, or 90% of the cost of federal operation of the airways system.

727 Parts Pooling

New York—Four domestic airlines awaiting delivery on the Boeing 727 are organizing a parts pooling program, coordinated by Trans World Airlines.

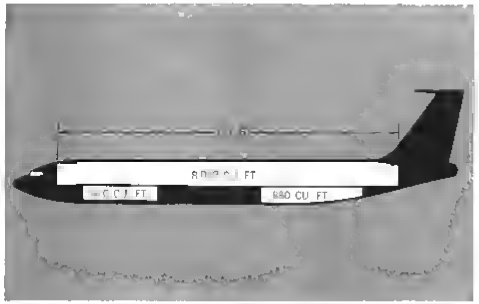
Carriers estimate that by sharing parts, rather than maintaining individual stockpiles at 727 stations they will save $3 million in capital investment.

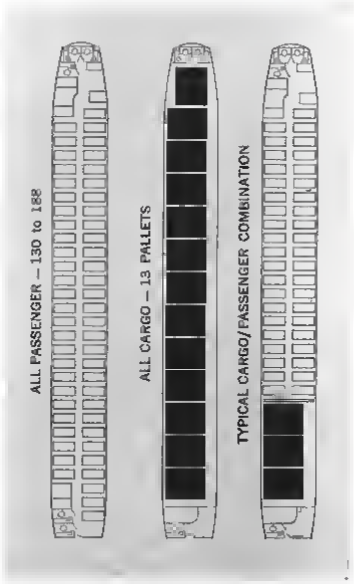
Program continues the pooling concept originated in 1959 by TWA and Pan American World Airways. Program today involves five pools and 39 airlines throughout the world.

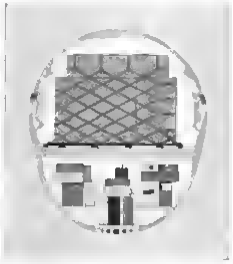
UAT Tanker Contract

Paris—French Defense Ministry has awarded a contract to a private French carrier Union Aeromaritime de Transport for maintenance of French air force's 12 Boeing KC-135 jet tankers.

UAT successfully competed against Air France despite the fact that it operates Douglas DC-8s while Air France operates Boeing 707s. Initial deliveries of KC-135s are scheduled to begin by year-end. Informed sources in Paris say that the French eventually may order an additional six KC-135s. Boeing tankers will be used in connection with FAF's Mirage 4-A bomber force.







World's lowest ton-mile cost

The new Boeing 707-320C cargo jet offers operators the lowest ton-mile costs of any transport aircraft, existing or proposed.

Boeing C Jets are quickly convertible from all-cargo to all passenger, or any combination required to take maximum profit advantage of varying cargo or passenger traffic. They can carry 45 tons of cargo over a 3,500 mile range. All economy passenger capacity is 188, or, in MATS type seating, 168.

Cruise speed with full payload is 575 miles an hour, providing next morning delivery of volume cargo . . . across a continent or an ocean.

The 320C is a development of the famous Boeing 707-320B turbofan Intercontinental the largest, longest-range commercial jetliner in existence. It incorporates the same major systems thus offering substantial savings through standardized spare parts ground handling equipment, maintenance and crew training.

C Jets have already been ordered by American Airlines, Pan American World Airways and World Airways. Deliveries begin this summer.

BOEING CARGO JET

Airline Traffic—December 1962

	Revenue Miles (000)	Originating Passengers (000)	Revenue Passenger Miles (000)	Revenue Passenger L/F (%)	Total Revenue Ton Miles (000)	Average Over-all Load (Tons)	Scheduled Miles (000)	Performance Factor (%)
DOMESTIC TRUNKS								
American	9,748	583	489,132	55	64,618	6 6	9,991	95 7
Braniff	2,530	181	91,282	51	10,713	4 2	2,538	97 5
Continental	2,151	125	92,636	50	10,298	4 8	2,166	97 6
Delta	4,878	335	223,251	56	25,882	5 3	5,091	93 5
Eastern	8,500	619	329,585	45	37,114	4 4	8,882	94 2
National	2,558	152	123,724	48	14,061	5 5	2,648	93 9
Northeast	1,557	101	55,248	46	5,759	3 7	1,772	85 0
Northwest	2,682	172	114,297	47	14,263	5 3	2,693	98 1
Trans World	7,662	398	383,240	49	46,055	6 0	7,783	97 0
United	13,842	835	597,298	51	74,730	5 4	14,266	92 8
Western	1,997	170	99,318	51	10,574	5 3	2,069	95 0
Trunk Total	58,185	3,671	2,599,813	51	314,067	5 4	59,899	94 6
INTERNATIONAL								
American	165	9	9,570	54	1,275	7 7	164	100 0
Braniff	281	9	11,324	43	1,456	5 2	283	99 1
Caribair	161	53	4,257	61	441	2 7	131	99 2
Delta	102	2	3,773	44	454	4 5	112	90 7
Eastern	980	44	65,812	55	7,429	7 6	972	96 6
Mackey	37	6	1,522	45	154	2 7	40	100 0
Northwest	950	20	38,032	44	8,027	8 5	839	96 5
Panagra	331	11	19,682	63	2,905	8 8	323	100 0
Pan American	9,142	321	548,913	54	87,213	9 5	9,054	94 2
South Pacific	11	1	404	45	42	3 9	11	100 0
Trans-Caribbean				Not Available				
Trans World	1,816	27	86,719	39	15,762	8 7	1,873	96 7
United	547	16	39,973	62	4,992	9 1	556	97 0
Western	177	8	12,105	70	1,310	7 4	177	100 0
International Total	14,720	527	862,886	52	131,460	8 9	14,535	95 3
LOCAL SERVICE								
Allegheny	826	67	14,316	38	1,574	1 9	893	91 7
Bonanza	497	36	9,592	51	960	1 9	507	97 8
Central	638	27	5,739	35	630	1 0	640	97 9
Frontier	935	35	10,191	36	1,110	1 2	939	98 4
Lake Central	506	32	5,200	36	577	1 1	540	92 5
Mohawk	825	75	15,609	44	1,434	2 0	877	91 3
North Central	1,210	82	14,352	37	1,612	1 3	1,201	99 1
Ozark	822	55	10,680	45	1,152	1 4	833	98 5
Pacific	438	36	8,098	44	808	1 8	498	87 1
Piedmont	834	51	12,292	39	1,315	1 6	909	90 8
Southern	666	34	6,808	35	743	1 1	744	86 8
Trans-Texas	665	31	7,464	36	800	1 2	677	96 8
West Coast	530	24	6,322	36	651	1 2	565	92 3
Local Service Total	9,392	585	126,663	39	13,566	1 4	9,023	94 3
ALASKA & HAWAIIAN								
Alaska Airlines	256	5	4,462	37	1,678	6 6	193	93 5
Alaska Coastal	107	7	555	33	73	0 7	93	87 5
Alaska	174	29	4,016	57	333	1 9	136	96 3
Cordova	43	2	205	34	40	0 9	29	91 3
Hawaiian	275	39	5,643	54	646	2 3	250	90 3
Kodiak	15	1	24	31	4	0 3	10	97 1
Mo Consolidated	128	1	446	25	169	1 3	97	96 8
Pacific Northern	342	10	8,377	28	1,714	5 0	327	92 1
Reeve Aleutian	85	1	790	26	234	2 8	76	78 9
Western Alaska	18	1	16	39	4	0 2	15	85 9
Wien Alaska	216	2	705	23	360	1 7	125	94 2
Alaska & Hawaiian Total	1,659	98	25,239	37	5,257	3 2	1,311	91 8
HELICOPTERS								
Chicago	29	5	91	33	9	0 3	29	97 4
Los Angeles	47	7	280	33	32	0 7	71	66 1
New York	36	15	328	39	34	0 9	49	69 1
Helicopter Total	112	27	699	35	75	0 7	149	73 3
CARGO & OTHER								
Aeravias				Not Available				
Avalon	27	6	325	54	32	1 2	8	96 4
Flying Tiger	1,071	3	14,138	78	15,145	14 1	459	92 4
Riddle	993	3	13,090	91	7,676	7 7	110	93 0
Seaboard	584	5	20,930	97	10,241	17 5	344	100 0
Slick	758	2	8,971	62	10,558	13 9	163	89 3
Cargo & Other Total	3,435	19	57,454	83	43,652	12 7	1,084	94 4
Industry Total	87,423	4,927	3,671,154	51	588,877	5 8	86,801	94 6

Management Shift Spurs Iberia Expansion

By L. L. Doty

Iberia Air Lines of Spain is undergoing a sweeping change in operating policy that is expected to remold it from a governmentally restrained carrier with limited services into a powerful competitor in world-wide markets.

The new policy places a heavy stress on sales and promotion backed by a far reaching expansion of Iberia's routes and services. It has the full support of Instituto Nacional de Industrias (INI), the government agency controlling the airline, although at least one phase of the policy may run contrary to positions held by some top-level government heads, including dictator Francisco Franco.

For a number of years, Iberia has been hampered by two contending factions within its management structure (AW July 3, 1961, p. 34). One faction, which ruled Iberia's destiny until only recently, held that the airline's role should be confined to its natural markets in Spanish-speaking countries and that North Atlantic services should be operated only as a diplomatic and national prestige device.

The opposing group, which has wrested control of management from the old group headed by Tomas Delgado Perez de Alba and Cesar Gomez Lnera, is driving for more airplanes, more routes, more sales offices and more money for advertising and promotion.

Thirteen new sales offices are being opened in cities throughout the world, including Lima, Hong Kong, Bombay, Manila, Copenhagen and Stockholm. The number of sales offices in the U.S. is being doubled.

In addition, Mariano de las Penas, director of traffic and sales, has obtained several Spanish sales representatives from TWA's Madrid office and given them top assignments, in hopes of bringing U.S. sales techniques into his operation. German L. Vazquez came from TWA to be Iberia's sales manager and Manuel Pinto, also formerly with TWA, has been moved to New York as Iberia's sales manager for U.S. and Canada.

Juan Vinuegra, who has been in the vanguard of the drive for more sales and promotion, has been named secretary general of the new management, a top position but one which appears to carry no functional activity within the sales area. Vinuegra reports directly to Director General D. Lazaro Ros, new head of the airline.

The new management is quietly formulating plans to counter any moves the U.S. government may make toward restricting capacity of its flights. Under the proposed U.S. air policy on international air transportation, attempts may be made to persuade foreign flag carriers serving the U.S. to put a ceiling on flight frequency and capacity until traffic demands catch up with available seat miles (AW Feb. 11, p. 38). Iberia now plans to increase its North Atlantic flight frequency to New York from three weekly to six beginning Apr. 1.

It has ordered two Douglas DC-8 jet transports to add to its present fleet of four and will increase its Sud Caravelle fleet from six to eight.

Major reason behind Iberia's fleet expansion is to improve its share of traffic on the North Atlantic. As a result, the airline will not accept capacity restrictions without taking some retaliatory action.

In addition, the Spanish may impose some capacity restrictions of their own on U.S. carriers if the Pan American-TWA merger is approved and they feel the merged carrier is providing too much competition on the North Atlantic route. Spain has consistently rejected a U.S.-proposed bilateral revision calling for a Madrid stop for Pan American on its U.S.-South African route.

How Iberia will go about imposing restrictions has not yet been determined. However, Iberia officials like to quote an official of Lufthansa who once said, in effect: "If the U.S. can discover a way of reinterpreting the bilateral agreement to its advantage, the Germans can also discover a way to reinterpret to their benefit."

It is on this point that Iberia may clash with Franco. Franco wants to attract as many tourists as possible to Spain, and he is not particular how they get there. He will quash any policy that will in any way restrict a tourist's choice of transportation to Spain.

The bilateral air transport agreement governing Spanish-U.S. civil air operations is not the Bermuda-type, but is based on the Chicago Convention, which makes no provision for fifth and sixth freedom traffic. Iberia, however, could restrict the volume of fifth freedom traffic earned by TWA from Madrid to Rome as a retaliatory measure against U.S. capacity control.

For years, Iberia had the smallest share of traffic of all carriers operating on the North Atlantic route. Its U.S. sales staff was efficient but small, and funds were not available to support effective advertising and promotional campaigns. Limited frequency of flights was an inconvenience to passengers and Iberia was virtually ignored by its stronger competitors.

Major overseas markets for Iberia were Mexico City and Caracas, Venezuela. Flights eastbound out of Havana were profitable until service was stopped last October because of the Cuban missile crisis, but westbound flights into Havana were operated at a heavy loss. The pattern is expected to continue with the resumption of service into Havana earlier this month (AW Feb. 18, p. 41). Eight passengers were on the first westbound flight and 23 boarded the eastbound flight out of Havana.

Global expansion of its routes, emphasis on the U.S. market and the application of modern marketing and sales techniques is expected to give Iberia the lift it needs to attain the stature of a major international carrier.

Initial success of the new approach has already been reflected in last year's traffic results. After years of operating with a static business volume, the number of passengers carried in 1962 reached a total of 1.2 million, an all-time high for the airline.

One problem that Iberia must overcome is the tendency of U.S. tourists to enter Europe through such gateways as Paris, London and Rome and embark for home at Madrid or Lisbon. This has created a single-directional flow of traffic for Iberia.

Increasing popularity of Spain as a tourist center could off-set this problem, but the best solution appears to be in the opening of a second European gateway. In the past, equipment shortage has prevented the carrier from asking its government to make a bid for a new gateway. Under Iberia's new management such a move may be made.

Douglas Facility

Santa Monica, Calif.—Douglas Aircraft has established a new subsidiary—the Douglas Finance Corp.—to ease financing problems of domestic and international carriers planning to purchase DC-8 and DC-8F passenger and passenger-cargo planes.

Step was taken to assist small carriers, which might have difficulty borrowing funds to purchase new aircraft because of credit problems. The new corporation will provide loan-guaranty services, also will act as loan negotiator for customer loans from other sources.

Douglas Finance Corp. will be located here. It was formed with a capital stock of $10-15 million. Services of the finance company would be extended to customers of the proposed 2086 turbojet medium range transport, if Douglas decides to produce the aircraft (AW Feb. 4, p. 38).

THE BAC ONE-ELEVEN IS POWERED BY TWO ***ROLLS-ROYCE*** *SPEY TURBOFAN ENGINES*

WITH THE SHORT HAUL JET

The BAC One-Eleven is on final assembly. It has already been ordered by BRITISH UNITED AIRWAYS, BRANIFF INTERNATIONAL AIRWAYS, MOHAWK AIRLINES, KUWAIT AIRWAYS and CENTRAL AFRICAN AIRWAYS. Passenger appeal and low break-even factors make the BAC One-Eleven the first choice for all short haul operators. The BAC One-Eleven is the jet successor to the Viscount with even better than Viscount economics.

BAC ONE-ELEVEN

BRITISH AIRCRAFT CORPORATION

ONE HUNDRED PALL MALL LONDON SW1 ENGLAND

USA BRITISH AIRCRAFT CORPORATION (USA) INC.,
399 JEFFERSON DAVIS HIGHWAY, ARLINGTON 2, VIRGINIA

BAS 31A

AIRLINE OBSERVER

► Local service airlines' spectacular passenger traffic gains continued in January, when revenue passenger miles increased 15.6% over January, 1962. Available seat miles for the month showed a 17.9% increase, lowering the group's load factor for the month to 40.5%, from the 41.3% in January.

► **British Overseas Airways Corp. has had preliminary talks with Aeroflot on a cooperative plan for flying Americans to Moscow from New York via London, where passengers would transfer from BOAC to British European Airways or Aeroflot. Latter two airlines have a revenue-sharing agreement on the London-Moscow route. Aeroflot told BOAC that 16,000 Soviet tourist visas are issued to Americans each year, and the figure is growing. Meanwhile, there are no signs that the U.S. is ready to act on the Soviet-U.S. bilateral air transport agreement, which has been initialed by both countries but not formally signed.**

► Russia's Aeroflot fell short of its 1962 cargo and mail goals by an even wider margin than it missed its passenger target (AW Feb. 11, p. 47). In the Russian Republic, which has more than half of the USSR's population and over 75% of its area, the Soviet airline monopoly's cargo tonnage increased only 10% in 1962 and mail tonnage rose only 2%. Aeroflot's total cargo and mail tonnage for the entire USSR was "almost a million" metric tons last year, compared with 843,000 tons in 1961. Passengers carried in 1962 totaled 27 million, three million less than planned.

► **Allegheny Airlines has warned the Civil Aeronautics Board that federal subsidy to local service airlines cannot be cut 50% by 1970, as suggested by a Board planning office, without drastically and arbitrarily curtailing air service to many communities.**

► Watch for BOAC to push for British government permission to enter the military charter haul fleet, so it can utilize its 12 Bristol Britannia turboprop transports now grounded at Cambridge Airport awaiting a buyer. BOAC has kept away from charter business because such activity was the primary source of revenue for independent carriers. The airline now feels that it should have a share in military contracts since independents are being granted more scheduled passenger routes under a new government policy.

► **CAB Chairman Alan S. Boyd last week met with Laurence K. Walrath, chairman of the Interstate Commerce Commission, and Thomas E. Stakem, chairman of the Federal Maritime Commission, in response to President Kennedy's request that the three agencies meet periodically to seek coordinated solutions to common transportation problems. One of the several points discussed covered the need for facilitating joint and through rates between various modes of transportation.**

► Harold Bamberg, former director of BOAC-Cunard who resigned in a dispute over policy, has purchased 60% of Cunard Eagle Airways from Cunard Steamship Co. Transaction does not involve any link with BOAC, but centers on a pattern of European scheduled service. The airline's name probably will revert to the original Eagle Airways which Bamberg founded in 1948. Equipment at present includes two Bristol Britannia 312 turboprop transports, two Vickers Viscount turboprops and three Douglas DC-6B transports, all based at London Airport.

► **Smaller trunklines continue to show sharp gains on the New York Stock Exchange, with several recording new highs for the 1962-63 period during the past few weeks. Northwest, National and Western common stocks have been particularly strong.**

► Trans World Airlines has revised the organizational structure of its finance department. Under the plan, James J. Kerley relinquishes the title of treasurer but remains head of the department as vice president-finance. New treasurer is Howard Swanson, who will join TWA next month from the National Broadcasting Co. B. H. Tumey becomes assistant to Kerley and James F. O'Crowley, Jr. succeeds Tumey as controller. TWA has also named Robert S. Senator as senior director of integrated data processing.

SHORTLINES

► **American Airlines** last week swelled the flood of promotional fares by proposing a half-fare plan for U.S. military personnel on leave or furlough. In addition, as of late last week most trunklines had filed a half-fare family plan tariff with the Civil Aeronautics Board (AW Feb. 13, p. 52).

► **British Overseas Airways Corp.** has entered into the trading stamp field through an agreement with Green Shield of Great Britain. Under the plan, Green Shield stamp books could be turned in to a travel agent or the stamp firm for cash allowances on the price of a BOAC ticket. Airline would not handle the stamp books.

► **Commercial helicopter** sales by Bell Helicopter Co. and its Italian and Japanese licensees in 1962 totaled 207 units and spares, valued at $24.7 million, compared with 194 helicopters and spares valued at $16 million in 1961.

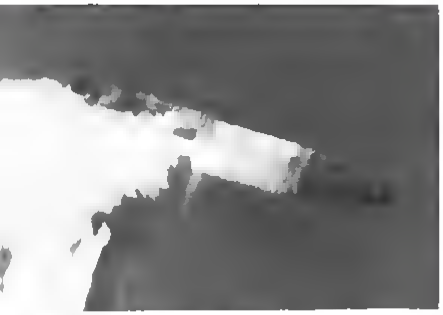
► **Convention on the International** Recognition of Rights of Aircraft has now been ratified by 19 nations including the U.S., according to International Civil Aviation Organization (ICAO). Purpose of convention is to protect property and other rights of aircraft operators in international operations.

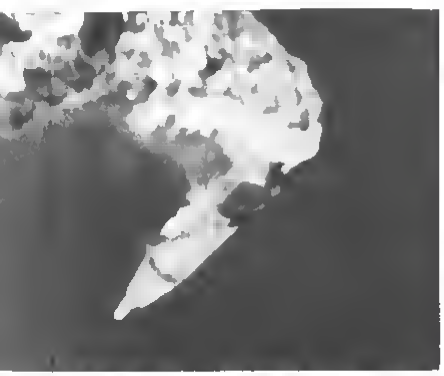
► **Federal Aviation Agency** will hold a special one-day conference Apr. 5 to discuss revision and modernization of regulatory requirements for aviation mechanic schools.

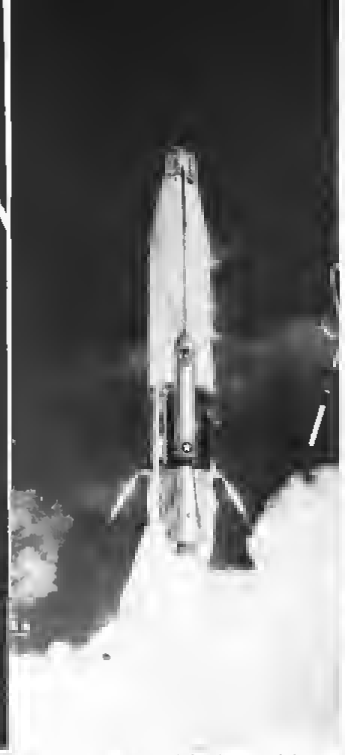
► **ICAO** air navigation commission is asking governments for comments on a proposal by the World Meteorological Organization to use the meters-per-second unit for reporting wind speeds in international aviation. ICAO procedures specify the knot as the only unit to be used for the reporting of wind speeds.

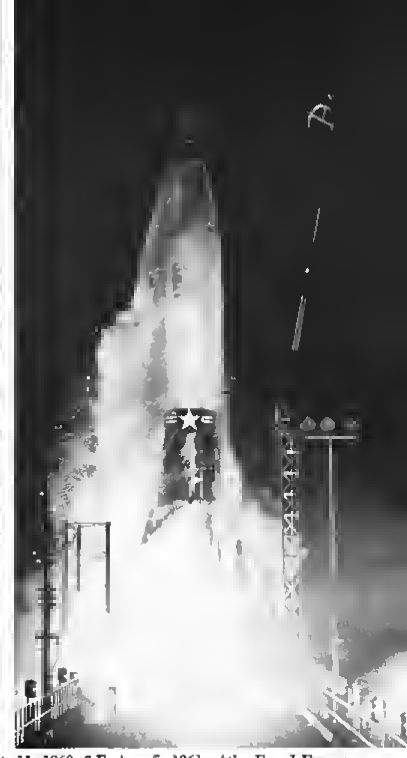
► **Lake Central Airlines** will report a net profit for 1962 of approximately $200,000 after the application of a tax loss carry forward. The airline reported a net loss of $61,137 in 1961.

► **United Air Lines'** one-class service tariff has been approved by CAB. The new fare will go into effect Mar. 10 on the Cleveland, Chicago and San Francisco route and will be extended to Chicago-New York on Apr. 1. Tentative plans are to begin the fare between Washington, Chicago and San Francisco on Apr. 28.









FIRST ATLAS to be flown during the weapon's five-year flight test program from Cape Canaveral was 4-A on June 11, 1957 (left). It was destroyed after 50 sec. when both engines shut down prematurely. Other photos, reading from left to right, show first Atlas launch in each series: 3-B, July 19, 1958; 3-C, Dec. 23, 1958, 3-D, Apr. 14, 1959, 3-E, Oct. 11, 1960; 2-F, Aug. 5, 1961. Atlas E and F series missiles have landed within 1.5 naut. mi. of Atlantic Missile Range targets about 80% of the time.

Atlas Accuracy Improves as Test Program Is Completed

By George Alexander

Cape Canaveral, Fla.—Air Force confidence that it can, in the event of war, deliver nuclear warheads to within 2 naut. mi. of targets in the Soviet Union and Communist China with 80% of its 126 Atlas intercontinental ballistic missiles is based on the weapon system's five-year flight test record from here.

Atlas E and F-series missiles, guided by the American Bosch Arma Corp. all-inertial system, landed within 1.5 naut. mi. of Atlantic Missile Range targets about 80% of the time. Atlas D series missiles, guided by the General Electric-Burroughs Corp. radio command system, struck within 1 naut. mi. of targets with a frequency above 80%. In fact, some GE-guided Atlases pushed the Missile Impact Location System (MILS) out to its limit of accuracy—about 0.15 naut. mi.—on several occasions. When the Atlas program began more than eight years ago, accuracy within a radius of 5 naut. mi. was envisioned.

Accuracy and reliability of the Atlas manufactured by General Dynamics/Astronautics were built upon the flight tests of 87 research and development missiles over the last five years. Subsystems, systems and the complete missile system were intensively tested. Improvements were made and these were checked until both customer and contractor were satisfied. Atlas test program, which began here with the failure of Atlas 4-A on June 11, 1957, was completed with the successful launch of 21-F Dec. 5, 1962.

In between these two Atlases, which were similar in name and concept only, were 85 other missiles of varying configurations, varying objectives and varying degrees of success.

As the first major U.S. long-range ballistic missile effort, Atlas served as a pathfinder in several uncharted technical forests. Astronautics engineers point to these advances in missile technology made by Atlas:

• **Thin-skin construction.** Atlas airframe, 0.032-in. at its thickest, basically is a stainless steel balloon which relies on gas pressure for rigidity. The weight savings of an airframe made lighter by the absence of stringers or stiffeners is passed on in the form of heavier payloads, longer ranges or both. "Inside of 15 years," another Astronautics engineer said of Atlas' unique structure, "industry will come back to our thin-skin design, either for a Nova or a redesigned Saturn. When you talk about vehicles of that size, it's silly to waste that much weight just to hold propellants."

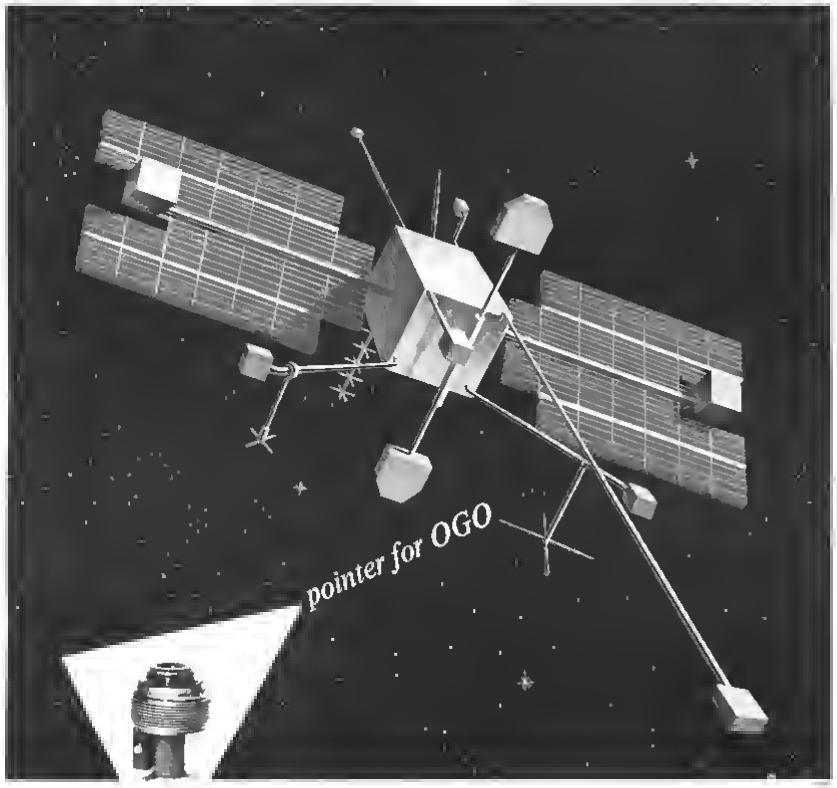
• **Contaminant control** in liquid oxygen systems. "As a result of the Atlas program and techniques developed for it," one engineer said, "Air Force now can detect the presence of hydrocarbons on a tank surface with IR [infrared] spectrophotometers down to a level not originally imagined possible by the [spectrophotometer] manufacturers." Using conventional spectrophotometers slightly modified for the Atlas program, Air Force Missile Test Center's Propellant and Chemical Laboratory is able to detect as little as 2 micrograms of hydrocarbons per milliliter. Normal threshold of the unmodified equipment is about 40 micrograms per milliliter.

At the beginning of the Atlas program, General Dynamics/Astronautics (CD/A) established 175 microns as the maximum allowable size for any foreign particle in the Atlas liquid oxygen ground or airborne system. After five years of flight, ground and laboratory testing, CD/A found this estimate to be overly cautious. Today, particles as large as 1,000 microns are tolerated. But where the company originally thought one square foot of internal tank surface could carry as much as 4,000 micrograms of hydrocarbons without danger, today only 2,500 micrograms per square foot are allowed.

• **Staging.** Atlas, a stage-and-a-half design, lifts off with all three engines burning. The two outer engines, the boosters, are jettisoned after 120-125 sec. of flight. The middle engine, the sustainer, burns for another 170 sec. At booster engine cut-off (BECO), these engines, which are mounted on a common frame bracketing the sustainer, are explosively separated with their frame from the airframe. The entire section then slides off Atlas on a set of rails. Problems inherent in staging—timing, hardware clearances, shifting center of gravity, flight control response and adaptability—were first explored in depth with Atlas.

• **Liquid oxygen handling.** At the beginning of the Atlas program, liquid oxygen was approached in much the same cautious way as liquid hydrogen is treated today. Thor, Jupiter and Redstone, shorter-range ballistic missiles, were in the early days of 1957 manually loaded with propellants from trucks driven alongside the launch stand. Flow rates were 300-400 gpm. "Atlas was the first to load remotely," one Douglas Aircraft Co. engineer said, "and the flow rates were much higher than ours [Thor]." GD/A experimented with two main ways of loading liquid oxygen aboard a missile—topping and slug filling. Comparatively the slower, the first method pumps liquid oxygen aboard Atlas at about 30,000 gpm. which allows chill-down of both the ground system and the missile. Last several hundred pounds of the cryogenic oxidizer added to the tank's normal flight load of 160,000 lb. are supercooled below the liquid's nominal —297F. This topping lowers the temperature of the entire liquid oxygen mass and reduces boil-off of the oxidant from its liquid to its gaseous state. This method was used on Atlas A, B, C and D series missiles.

Second method calls for rapid transfer of liquid oxygen from storage tanks into the missile by helium under high pressure. It was designed to be used



Once in orbit, OGO (NASA's Orbiting Geophysical Observatory) must orient scientific equipment in three directions. Some of its experimental packages must line up perpendicular to the sun's rays. Other experiments must turn to face the earth. Another group must seek a line parallel to OGO's own orbital plane. STL engineers and scientists have produced a hermetically sealed drive mechanism to help solve these orientation requirements. Two mechanisms are used in OGO's attitude control system. One rotates solar arrays in continuous orientation with the sun a second keeps experiment packages fixed in desired position with respect to the orbital plane. The drive mechanism (shown above) is hermetically sealed to permit use of a conventional high-speed servo-motor without the usual problems of gear lubrication. It does its work by wabble or twist motion at a rate of one degree per second with a final gear reduction of about 24,000 to 1. STL's many projects include building OGO spacecraft for NASA's Goddard Space Flight Center, building spacecraft for Air Force-ARPA, and continuing Systems Management for the Air Force's Atlas, Titan and Minuteman programs. These activities create immediate openings in fields such as: Space Physics, Radar Systems, Applied Mathematics, Space Communications, Antennas and Microwaves, Analog Computers, Computer Design, Digital Computers, Guidance and Navigation, Electromechanical Devices, Engineering Mechanics, Propulsion Systems, Materials Research. For Southern California or Cape Canaveral positions, write Dr. R. C. Potter, One Space Park, Dept. A-2-5, Redondo Beach, California or P. O. Box 4277, Patrick AFB, Florida. STL is an equal opportunity employer.

Atlas' Role in Space Missions Listed

Twenty Atlas D-series missiles and one m B-series have been used by Air Force and National Aeronautics and Space Administration as boosters for a variety of space missions. Ultimate criterion of Atlas performance as a space booster must be based on whether it delivered its payload to the proper point in space. By this reckoning, Atlas 10-D is considered successful although the booster malfunctioned. 10-D was programed to fly a Big Joe Mercury capsule on a ballistic trajectory down the Atlantic Missile Range to test the spacecraft's re-entry heating. When the Atlas booster engines failed to separate, the capsule was placed on a re-entry angle much steeper than planned and experienced much higher heat loads than anticipated. When the capsule withstood these higher loads, NASA rated the mission a success and canceled plans for a second similar flight.

Space missions using Atlas boosters include:

- 10-B, Dec. 18, 1958. Project Score. Booster and mission success.
- 10-D, Sept. 9, 1959. Mercury Big Joe. Booster and mission success.
- 20-D, Nov. 26, 1959. Atlas Able 1. Failure.
- 50-D, July 29, 1960. Mercury Atlas-1 (MA-1). Failure.
- 80-D, Sept. 25, 1960. Atlas Able 5A. Failure. Booster was damaged by payload fairing which came loose early in flight and struck the side of the Atlas.
- 91-D, Dec. 15, 1960. Atlas Able-5B. Failure. Premature second stage ignition for causes undetermined destroyed the launch vehicle.
- 67-D, Feb. 21, 1961. Mercury Atlas-2 (MA-2). Suborbital ballistic shot. Booster and mission success.
- 100-D, Apr. 25, 1961. Mercury Atlas-3 (MA-3). First orbital attempt. Failure.
- 111-D, Aug. 23, 1961. Ranger 1. Booster success, mission failure.
- 88-D, Sept. 13, 1961. Mercury Atlas 4 (MA-4). First orbital flight. Booster and mission success.
- 117-D, Nov. 18, 1961. Ranger 2. Booster success, mission failure.
- 93-D, Nov. 29, 1961. Mercury Atlas 5 (MA-5). Orbital flight of Enos, chimpanzee. Booster and mission success.
- 121-D, Jan. 26, 1962. Ranger 3. Booster guidance failure, mission failure.
- 109-D, Feb. 20, 1962. Mercury Atlas 6 (MA-6). Orbital flight of John Glenn. Booster and mission success.
- 133-D, Apr. 23, 1962. Ranger 4. Booster success, mission partial success. First U.S. payload to impact on the moon.
- 104-D, May 5, 1962. Centaur. Failure. Insulation panels around Centaur stage came loose, damaging booster and eventually destroying entire launch vehicle.
- 107-D, May 24, 1962. Mercury Atlas-7 (MA-7). Orbital flight of Scott Carpenter. Booster and mission success.
- 145-D, July 22, 1962. Mariner 1. Failure. Booster guidance equation incorrect. Destroyed by range safety officer.
- 179-D, Aug. 27, 1962. Mariner 2. Venus fly-by. Booster and mission success.
- 113-D, Oct. 3, 1962. Mercury Atlas-8 (MA-8). Orbital flight of Walter Schirra. Booster and mission success.
- 215-D, Oct. 18, 1962. Ranger 5. Booster success, mission failure.

Using the Atlas D-Agena launch vehicle, Air Force has launched at least five Midas and 12 Samos satellites. First two Midas spacecraft were launched from Cape Canaveral; all the others, including Samos, have been launched from Pt. Arguello, Calif., adjacent to Vandenberg AFB. Dept. of Defense has not announced the results of any of these flights since Nov. 22, 1961, but it is understood that only one Midas and three Samos satellites failed to achieve orbit.

Midas successes were recorded May 24, 1960, July 12, 1961, Oct. 21, 1961 and Apr. 9, 1962. Lone failure occurred on the first launch attempt, Feb. 26, 1960, and was attributed to the Agena.

Samos successes were recorded on Oct. 11, 1960, Jan. 31, 1961, Dec. 22, 1961, Mar. 7, 1962, Apr. 26, 1962, June 17, 1962, July 18, 1962, Aug. 5, 1962, Nov. 11, 1962. Three failures were Sept. 9, 1961, Nov. 22, 1961 and Dec. 17, 1962.

on the Atlas E and F series missiles to provide fast reaction time.

Both methods sought to reduce geysering—the formation of gaseous oxygen bubbles within the liquid mass. Geysering can become severe if the missile stands in sunlight for any length of time and engineers generally consider a missile lost if the turbopumps of its engines ingest bubbles along with propellant. Gas-driven pumps are held at constant speed by a full volume of liquid propellant. Bubbles cause a sharp pressure drop when they enter the impellers of the pump, the pump over speeds, then overheats and finally explodes.

GD/A found that the best way to avoid this was to delay liquid oxygen loading until the last practical moment in the countdown and then to slug fill the tank rapidly, topping it just prior to launch with vapor-cooled oxidant. Present operational Atlas squadrons use this combined loading method and so does industry with some variations. Chill-down times and boil-off are reduced considerably.

GD/A and USAF project engineers emphasize the fact there were no comparible long-range programs prior to Atlas from which their weapon could benefit, as successive programs have benefited from Atlas' experience. "Titan-I saved itself time by going straight to our LOX loading methods," one engineer said. "In a lot of [missile technology] areas," another said, "Atlas was the first to do any extensive development work."

Acquisition of this fund of knowledge was not always painless. Of 87 research and development Atlases, 10 were classified as failures and 18 as partial successes, which also is to say partial failures. B. C. MacNabb, GD/A director of launch operations at Cape Canaveral, and other industry spokesmen say that a failure is total only when the test yields absolutely no data.

"We generally learned something from each failure," MacNabb said. "Usually, it took us two flights to correct a problem. After it cropped up on the first flight, we would analyze what went wrong and try to figure out just what had happened. Then we would instrument the next bird to cover those possibilities and if it failed again in the same way, well, we knew the reasons. But if you had a number of things go wrong [on one flight], then the reasons could get buried among themselves and it might take several more flights before you could unravel the whole thing," he said.

The first two Atlases, 4-A and 6-A, flown in the flight test program exemplify this. About 24 sec. after liftoff, one of 4-A's two booster engines suddenly shut down and the vehicle yawed sharply in the direction of the dead engine. Three sec. later, the other engine also quit and 4-A rotated in a complete loop, nose toward the ground and engines toward the sky. At about 50 sec., after liftoff, the range safety officer destroyed the vehicle.

Post-flight analysis led GD/A and USAF project personnel to suspect two probable causes of 4-A's failure: recirculation of the engines' hot exhaust gases back into the thrust section through the gap of the missing sustainer engine (all Atlas As were powered by booster engines only) and vibrations which loosened some plumbing lines to the engines.

These areas were instrumented on the next Atlas, 6-A, launched Sept. 25, 1957, and suspicions were confirmed when this missile failed in a manner almost identical to that of 4-A. It was

First Photo Shows Gemini Recovery Area

Aerial view of Gemini Titan 2 Complex 19 at Cape Canaveral, Fla., shows the area being cleared and leveled by Martin Co., Titan 2 builder, for recovery of the two Gemini pilots in the event of a pad abort Legs of the triangular-shaped area are each 1,000 ft long and the angle between them is 54 deg All elevated obstacles are being removed, even pad illumination lights will be installed flush in the ground Cleared area will be deluged with water in the event of booster explosion In present Gemini capsule design, pilots' seats are angled at 9 deg above horizontal and 12 deg apart. Ejection motor on each seat will develop 2,500-lb thrust and burn for 1 sec, pilots should be clear of capsule 0.4 sec after motor ignition Barostats will activate seat-mounted chutes 3 sec later when pilots are about 300 ft above the ground Pilots will have a maximum of 5 5 sec. in which to initiate escape procedures after notification from range safety officer of his intention to destroy a malfunctioning booster One switch will eject both seats. Ejection seats will be the primary escape method up to 80,000 ft After that, pilots will escape by firing their spacecraft's four solid-propellant retrorockets, each developing 2,500 lb, and separating the capsule from the launch vehicle Pilots would then fly their capsule back to earth by paraglider NASA, Martin and Gemini capsule manufacturer, McDonnell Aircraft, are studying ways of pilot escape from the launch stand before the erector is dropped preparatory to engine ignition These include a cherry picker, high speed elevator, cork screw type slide and lifelines

determined that a low-pressure area was being created in the thrust section by the relative velocities of the engines' exhaust and the airstream down the side of the missile Hot exhaust gas was being drawn back up into this area, which was enclosed by a skirt, and was melting cabling and components, propellant flow-control and engine actuator systems were being destroyed

As a result of these two flight failures, a heat shield was installed just above the engines of subsequent vehicles, some plumbing was redesigned (an aluminum line was replaced by a stainless steel tube) and other lines and cables relocated and additionally insulated The thrust section skirt also was shortened by 19 in. to reduce the volume of the engine compartment and allow the exhaust gases greater dispersion freedom These fixes were incorporated on Atlas 12 A, which was launched successfully Dec 17, 1957

Thrust section heat shield is an example not only of a quick fix to an unexpected problem but also of a part which underwent a series of improvements until an optimum design was reached First heat shield was a metal slab with a deposit of pure gold on the side facing the exhaust gases Heavy and costly, it gave way to a dual sheet structure of aluminum and glass fiber This was replaced by the present aluminum honeycomb structure sandwiched between two sheets of glass fiber

Improvements to the Atlas system were made throughout the missile's five-year test program, but only where performance could be enhanced, complexity reduced or procedures simplified Thus, four or five different types of anti-slosh baffles were tested in Atlas propellant tanks before one design finally was chosen, a heat shield was added to the engine compartment, a miniaturized and mostly solid-state autopilot replaced its electromechanical predecessor, etc The list is lengthy

But when it was discovered that the sustainer engine was consistently and unexplainably running 4 to 5% below designed specific impulse, nothing was done to correct the deficiency Since all other performance parameters of the engine were satisfactory and the thrust difference—about 3,000 lb—was within tolerance limits, it was felt unwise to tinker with an otherwise reliable powerplant

This was the basic philosophy followed by USAF and GD/A in the development of Atlas, it was designed to meet Air Force's urgent requirement of a usable weapon during early 1959 This deadline for an initial—or interim, according to some—operational capability (IOC) was predicated upon USAF's estimate that the Soviet Union would have a strategic missile force in being around 1960

When Atlas was under design in 1954-56, it was realized that the most effective ballistic missile weapon system would be one guided by a jam proof all-inertial system and carrying a high-Mach ablative re-entry vehicle Since these two critical elements appeared beyond the grasp of the then-existent technology and therefore unavailable by 1959, it was decided to follow a technical road which would eventually result in a "most effective" weapon but which also would allow an interim weapon to be pulled out of the development cycle to meet the 1959 requirement

This interim weapon was to be equipped with radio-command guidance

and a heat sink type of nose cone. Since these were less complex than their advanced counterparts—all inertial guidance and ablative re-entry—it was felt that they could be developed in time to meet the 1959 requirement. This early Atlas weapon was to be designated the D series.

Entire program was to run much like a conveyor belt, with a steady supply of basic vehicles coming down the line at GD/A's San Diego, Calif. plant. Modifications dictated by test flights at the Cape were to be incorporated in missiles on the line.

Rather than wait for all major elements of the weapon system to reach developmental maturity before starting flight tests—and possibly miss the 1959 date—Air Force decided to begin launches in April, 1957, with the hardware then at hand and to add elements as they became available.

Booster Tests

For example, when the propulsion system configuration was frozen during the design phase, it included an engine—the sustainer—which had not even been designed. Rather than delay the program, flight tests began with Atlases powered only by the two booster engines. By the time the sustainer was available in 1958, eight Atlases had been launched and useful data acquired on booster performance. Airframe design also was validated during this one year period.

The six series (A through F) which were flown during the Atlas test program were based on only two vehicles: the research and development vehicle and the operational weapon. A, B and C series were the research and development vehicle. E and F series were the operational weapon. Some consider the D series Atlas a research and development vehicle converted for operational use, others call it a prototype weapon. In either event, Atlas D was the first to be delivered to Air Force as a weapon.

Series designated a block of Atlases with common test objectives. A, B and C-series missiles usually tested major elements of the Atlas system. D, E and F series usually tested the system as a complete entity, including ground based elements.

Eight Atlas As were flown from the Cape between June 11, 1957, and June 3, 1958. Basic objectives of the A series were: overall performance and compatibility of the booster engines, autopilot system and airframe, including the pneumatic, hydraulic and electrical systems. Only a minimum of systems necessary for flight was carried and programed range normally was 600 mi.

Violent maneuvers of Atlases 4-A and 6-A, prior to their destruction by the range safety officer, proved that the pressurized airframe could stand up under dynamic forces far in excess of design specifications. Post-flight analysis of films of these two missiles revealed no deformation of the airframe during uncontrolled flight.

Heating Problem

Missiles 13-A and 13-A, launched Feb. 7 and Feb. 20, 1958, respectively, taught a hard lesson in aerodynamic heating. Both broke up late during booster operation when aerodynamic heating caused circuits in the vernier engines to fuse and then short. Resultant voltage surges led to complete loss of the flight control system, of which the verniers are part. Problem was solved by covering the 1,000-lb.-thrust engine with heat-resistant fairings.

Major problems uncovered by the A series, in addition to thrust section overheating and high aerodynamic heat loads, included resonant coupling of the missile's autopilot with the bending frequencies of the vibrating airframe (solved by adding a filter to the autopilot) and frothing of the lubrication oil in the booster turbopump gearbox. This last-mentioned problem was attributed to a lack of pressurization in the oil reservoir at the low pressures of high altitudes, the oil bubbled off. Reservoir consequently was pressurized and the problem solved.

Atlas-A Results

Results of Atlas A-series flights were estimated by USAF as:

- **Four successes**—12-A, Dec. 17, 1957, 10-A, Jan. 10, 1958, 11-A, Feb. 20, 1958, 16-A, June 3, 1958.
- **Four partial successes**—4-A, June 11, 1957, 6-A, Sept. 25, 1957, 13-A, Feb. 7, 1958, 15-A, April 5, 1958.

A missile that achieved 75% or more of its test objectives was rated successful. From 25 to 75%, it was a partial success and below 25%, a failure.

Ten B series vehicles were flight-tested between July 19, 1958 and Feb. 4, 1959. Atlas Bs carried practically all airborne systems intended for use on the initial operational weapon system including the complete Rocketdyne Div. of North American Aviation propulsion system and the GE-Burroughs guidance system. Series objectives were to test the performance of the three-engine propulsion system and staging of booster engines, to evaluate the nose cone separation mechanism, determine performance of the radio-command guidance system and evaluate an experimental monopropellant accessory power supply package.

Accessory power supply typified progress made in many subsystem areas during five years of flight testing. Initially,

Be fussy

Two things determine whether or not a particular printed circuit connector is "right" for your application:

1. How the printed circuit board mates with the connector; and

2. How the connector connects to the rest of the system.

Take mating, for example. Besides having the correct number of contacts, a printed circuit connector must hold the board securely whether the board happens to fall at the high or low end of thickness tolerances.

IT TAKES THREE

These considerations convinced Amphenol engineers that no single contact design could satisfy the requirements of a wide range of applications. So they designed three contacts that will.

One, used in Prin-Cir* connectors, looks a lot like a tuning fork with lips. The circle lip design makes contact overstressing or "setting" impossible—even after repeated insertions. The contact's long spring base also enables it to accommodate boards that range in thickness from .055" to .073" while doing an excellent "wiping" job.

EASY DOES IT

But not every application requires the Prin-Cir "bite." For this reason, Amphenol engineers designed connectors with ribbon contacts that mate with a gradual wedge-like force. In blind mating applications, gradual mating makes the feeling of *correct* mating unmistakable (just the thing when your equipment may eventually be maintained by less-skilled and less-concerned personnel.) Ribbon contact wedge action also makes it possible for connectors using these contacts to accept the same wide range (.055" to .073") of board thicknesses as do Prin-Cir connectors.

Finally, advances in micro-miniaturization (like Amphenol-Borg's Intercon® pre-fabricated circuitry) meant that tinier-than-ever-before connectors were needed. Amphenol's answer was the Micro-Min® receptacle and printed circuit board adapter. Micro-Min contacts are actually tiny springs of beryllium copper wire, formed in a precisely designed arc to assure firm circuit board retention. This unique design makes it possible to space contacts on .050" centers and crowd 19 connections into a little more than an inch of space.

TERMINATIONS COUNT, TOO

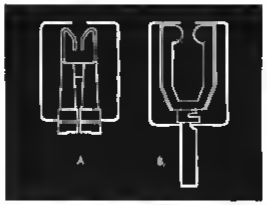
"How to connect connectors to the rest of the system" also merits a good deal of consideration. In some cases, hand soldered terminations will do just fine. In others, higher volume requirements call for high production rate methods like dip soldering and wire-wrapping. Some engineers prefer taper pin terminations.

Our printed circuit connectors are available with contact tails designed for each of these termination methods. In addition, adapters are available for use in connecting printed circuit boards at right angles to each other or in modular arrangements. We make printed circuit connectors with hermetically sealed contacts — still others with coaxial contacts.

Take your choice.

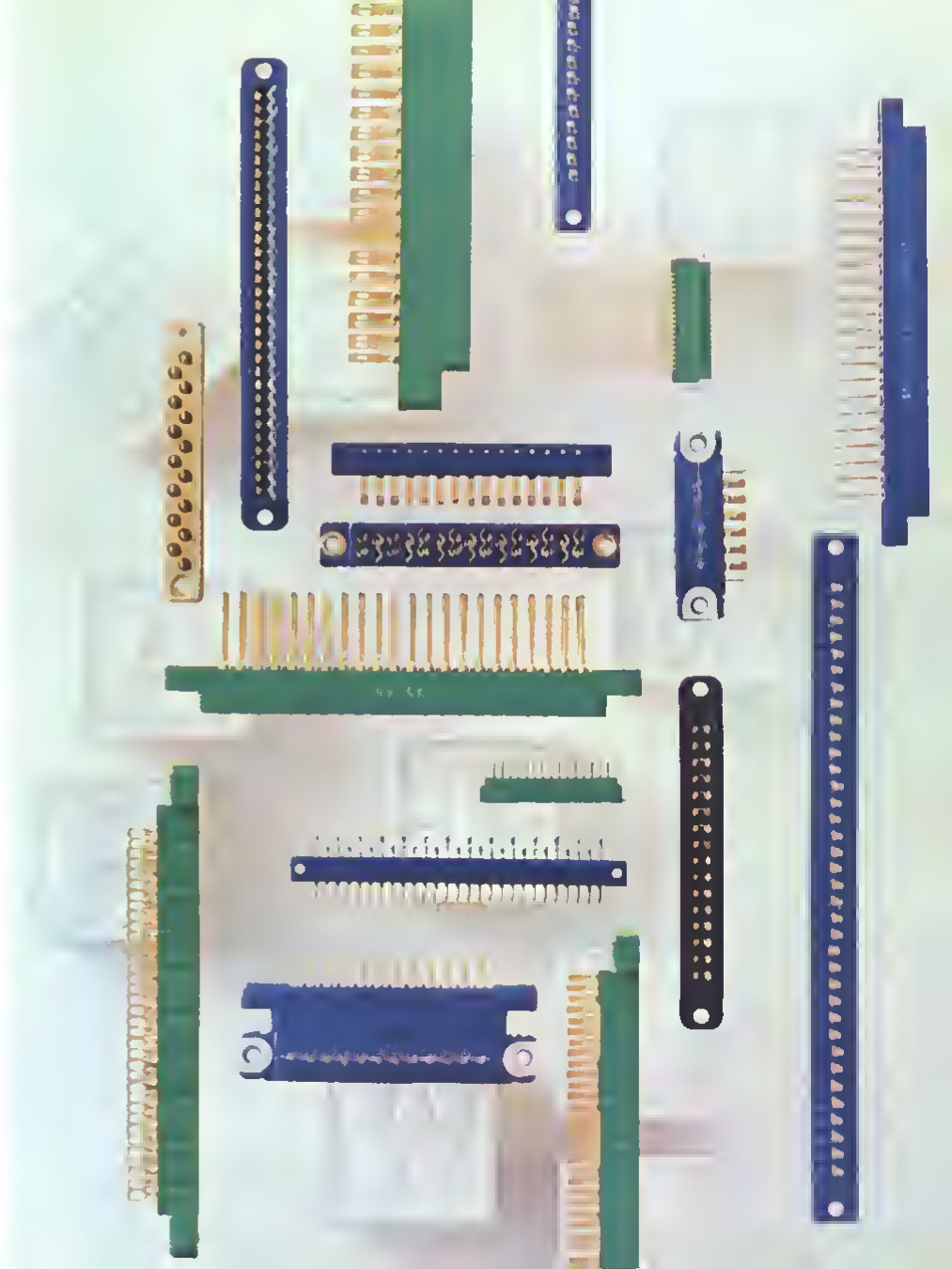
Any Amphenol Sales Engineer or authorized Amphenol Industrial Distributor will be happy to discuss printed circuit connectors (ours) with you. Or, if you prefer, write directly to Dick Hall, Vice President, Marketing, Amphenol Connector Division, 1830 S. 54th Avenue, Chicago 50, Illinois.

*T.M. Amphenol-Borg Electronics Corp.



Wedging action of Amphenol ribbon type (A) and long spring base of Amphenol Prin-Cir connectors (B) assure firm printed circuit board retention, whether board happens to fall at low (.055") or high (.073") end of thickness tolerance.

AMPHENOL **Connector Division** / Amphenol-Borg Electronics Corporation



GD/A had planned to use ... batteries to provide electrical power to the vehicle. Weight of batteries and the requirements of long storage time plus instant readiness capability, however, led GD/A and USAF to seek another power source.

Generator Tested

A hot gas-driven generator was tested aboard two Atlas As and several Bs, but the unit never completely satisfied GD/A and USAF. In the meantime, a dry battery with a liquid electrolyte contained in a separate reservoir was developed. Upon command the electrolyte could be released into the plates and the battery activated. Astronautics returned to batteries for power and part of the Atlas launch countdown today is the activation of the missile's silver battery.

Major difference between A and B Atlases was the deletion of the liquid oxygen supplementary tank pressurization system for sustainer engine operation.

This system was carried on A vehicles despite their lack of a sustainer engine for evaluation purposes. It was dropped from B vehicles when it was discovered that the helium pressurizing gas plus oxygen boil-off would be sufficient both to maintain airframe integrity and to provide a net positive suction head at the tank outlet to the engine at the low-pressure altitudes where the sustainer would be operating solo.

Development of the in-flight tank pressurization system was described by one engineer as "a real achievement." Helium is contained in seven high-pressure bottles located in the engine compartment and is drawn from these reservoirs during flight. Passed through a heat exchanger, it is warmed and expanded and then introduced into the tankage. Fuel tank is pressurized to about 60 psi. and the oxidizer tank directly above it to about 26 psi. Regulators hold these pressures to a tolerance of less than 0.5 psi. to preclude reversal of the common bulkhead between the two tanks.

Pressure differential is not as great as it might seem because of g-forces during flight on the relative masses of propellants. Atlas normally carries 170,000 lb. of liquid oxygen and 80,000 lb. of RP-1 kerosene-like fuel.

GE/Burroughs radio guidance system was flown open-loop on the last two Atlas A missiles, partially closed-loop on the first two Bs and completely closed-loop on the rest of the Bs, all of the Cs and all but seven of the D series. Open-loop means that the system was flown and operated aboard the missile but did not actually control the flight. Partially closed-loop means that it did not generate steering commands but otherwise operated normally in sequencing engine operations, flight controls, etc. Closed-loop means that the system controlled the flight completely. GE system made its first closed-loop flight aboard Atlas 5B Aug. 28, 1958.

Guidance System

Initial Mod 1 guidance system developed by GE consisted of a pulse-type tracking radar, rate transmitter and four rate receivers in an X-shaped configuration. Radar and rate transmitter were at the intersection of the X, with the four receivers at the ends of the X and connected by land lines to the former. A Mod 2 featured some minor improvements in the system but was only an interim step to the final Mod 3 design. Mod 3 system used only two rate receivers laid out at right angles to each other from the centrally positioned radar and transmitter. Pulse radar, which had a higher pulse repetition frequency than in earlier versions, gave position, range and elevation data of the Atlas. Rate system gave range, range-rate and velocity data through phase shift measurements.

"Right from the start," said one GE engineer, "we made careful statistical evaluations of each flight looking for bias errors." The company even made extensive studies of atmospheric refrac-

tion to eliminate refractive errors in transmissions.

Accuracy of the guidance system was evaluated by a "best estimate" analysis of the trajectory flown by the Atlas. This was a mathematical solution of the tracking data acquired by ballistic cameras. The GD/A developed Azusa tracking system and the GE system itself. Data from each system was weighted according to the quality of the data acquired by that system on a particular flight. Generally, the ballistic cameras were the standard for comparison.

Greater accuracy came with more experience. Procedures—of tuning, calibrating, checking out, installing and maintaining the guidance system—were of equal or greater importance than hardware improvements or elimination of bias errors, according to one GE engineer.

Impact Accuracies

Effort made by GE can be appreciated by the fact that from the middle of D-series testing on, impact accuracies were measured in tenths of a mile—e.g., 0.6 naut mi short or long, 0.5 naut mi wide to the left or right of target. During B and C series testing, while the system was still undergoing major development, some Atlases impacted from 10 to 15 naut mi short or long and from 5 to 10 naut mi wide.

Of the 10 Atlas Bs flight tested, six had been programed for ranges between 2,400 and 3,100 naut mi. Four reached their planned distances. Two others without separable nose cones had been programed for full 5,500 naut mi flights into the ocean impact area; only one—12 B, launched Nov. 28, 1958—was successful.

Test of Atlas 13-B

Atlas 13 B, launched Jan. 15, 1959, had been programed both for 5,500 naut mi range and separation of its re-entry vehicle. The Atlas performed satisfactorily but the nose cone did not separate cleanly. The test was rated a partial success. Atlas 10 B was Project Score, launched Dec. 18, 1958. Entire Atlas, minus only its two booster engines, went into orbit around the earth carrying a tape recorded Christmas message from President Eisenhower.

Results of Atlas B series tests were:

- **Six successes**—4 B, Aug. 2, 1958; 5 B, Aug. 28, 1958; 8 B, Sept. 14, 1958; 12 B, Nov. 28, 1958; 10 B, Dec. 18, 1958; 11 B, Feb. 4, 1959.
- **Two partial successes**—9 B, Nov. 17, 1958; 13 B, Jan. 15, 1959.
- **Two failures**—3 B, July 19, 1958; 6 B, Sept. 18, 1958.

C series testing began Dec. 23, 1958, almost 1½ months before the B series flights were concluded. When the bulk of the primary objectives of one series had been met satisfactorily, USAF started the next series. This overlapping was in keeping with USAF's drive to develop an operational weapon by 1959.

The six Atlas C-series missiles which were flown from Cape Canaveral incorporated a number of improved or re-designed subsystems and components as a result of A and B-series experiences. Major changes included:

- **Lighter gage airframe skin.** Thickness of the cold-rolled austenitic grade 301 stainless steel used in the manufacture of Atlas varies with airframe station. A and B series missiles had skins ranging from 0.024 to 0.060 in. thick.

C-series missiles were the first to be made of 0.020 to 0.040 in. thick stock, at one time the planned design of the weapon's airframe. Flight-testing, however, revealed that even thinner steel could be used in fabricating Atlas.

- **Readjustment of the oxidizer-fuel proportions.** In the beginning of the flight-test program, GD/A recognized that there were wide variations in the specific gravity of the RP-1 kerosene fuel delivered at Cape Canaveral. To accommodate fuel loads of varying density, GD/A positioned the common bulkhead separating the oxidizer and fuel tank volumes higher than necessary.

(Continued on page 69)

After final manufacturing achieved better quality control in making RP-1. The bulkhead was lowered 27 in. and the relative proportions of oxidizer and fuel changed—increasing the former and decreasing the latter.

• **Anti-slosh baffles.** A- and B-series Atlas had carried a variety of experimental baffles in each propellant tank. C series established the final configuration of the approximately 4-in. wide baffles as a series of about 12 rings spaced logarithmically from bottom to top inside the oxygen tank. Liquid oxygen tank also contains a unit at the bottom to prevent vortices. Fuel tank contains a perforated plate in the conical aft end to prevent both sloshing and vortices.

• **Propellant utilization system.** The CD/A-developed level sensor system first flown aboard B-series missiles was replaced by the more advanced Acoustica Associates, Inc. same system in ward the end of the D series. The Acoustica system presently is aboard Atlas E and F-series missiles. System constantly monitors amount of oxidizer and fuel remaining in both tanks and adjusts flow rates of each to maintain an even mixture in the engines.

One of the major objectives of the C series tests was demonstration of both the GE guidance system's accuracy and reliability and the adequacy of range safety procedures and equipment. Before launching missiles into the Ascension Island MILS net some 4,400 nautical mi. downrange of the Cape in the South Atlantic Air Force wanted to be certain that probability of a missile straying from its trajectory was slim and that if one did wander off course, range safety could catch the deviation in time to destroy the missile before it posed a hazard to any of the inhabited islands. Of particular concern to USAF was the British colony of Ascension Island, about 40 naut. mi. north and slightly west of the MILS net where re-entry vehicles would be landing.

Six Atlas Cs carrying the GE Mod-3 guidance system therefore were flown for ranges between 3,800 and 4,300 naut. mi. into the broad ocean area north of Ascension. Accuracies of these launches were determined by the Impact Predictor, an International Business Machines 7090 computer located at the Cape, and by Sofar bombs detonated in the ocean after re-entry vehicle impact for slant-distance measurements by range ships.

In addition to its prime objectives, Atlas C also made some bonus firsts. 8-C launched July 21, 1959, flew the first ablative re-entry vehicle, the RVX-2. This nose cone was fabricated by GE from materials developed by Avco Corp. Atlas 11-C, launched Aug. 24, 1959, carried a 16-mm. movie camera in its nose cone and returned the first films taken of the earth from an altitude of 700 mi.

Although the C-series did not disclose any new or major problems, two anomalies were noted: sustainer engine thrust ran slightly below specification (see above) and all three engines tended to run liquid oxygen rich during flight. Redesign of propellant valving solved the latter problem, but the former was disregarded as negligible.

Results of Atlas C series tests were:

• Three successes—3-C, Dec. 23, 1958; 8-C, July 21, 1959; 11-C, Aug. 24, 1959.

• Two partial successes—4-C, Jan. 21, 1959; 7-C, Mar. 18, 1959.

• One failure—5-C, Feb. 20, 1959.

D series, the configuration that Air Force intended to deploy operationally by the end of 1959, got off to a sputtering start in the flight test program. First Atlas D, 3-D, was launched Apr. 14, 1959, and exploded after 30 sec. Post-flight analysis led GD/A and USAF to

SAC Firings

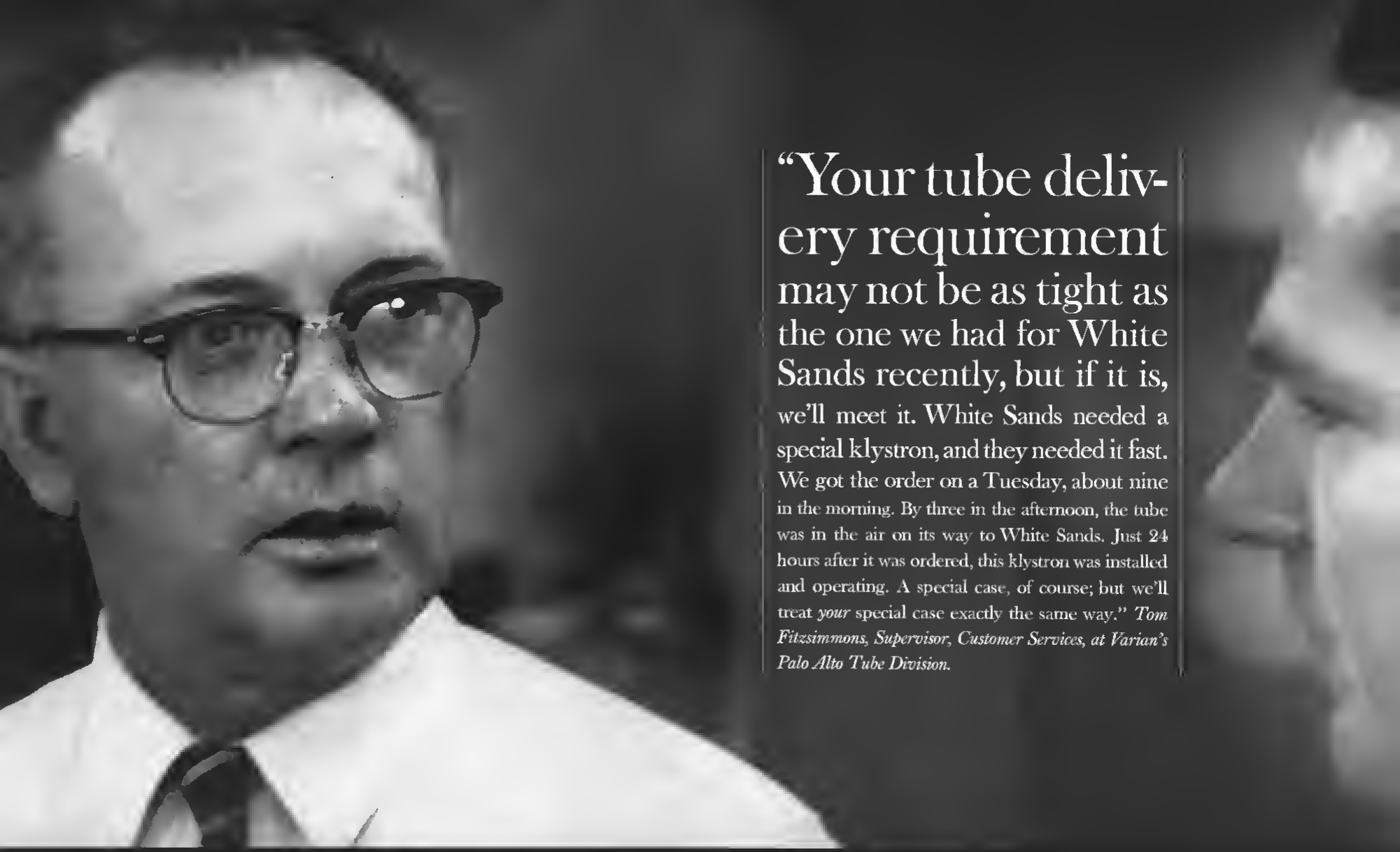
Strategic Air Command crews have launched 29 Atlases from Vandenberg AFB, Calif., in training exercises since Sept. 9, 1959, date of the first such launch. General Dynamics/Astronautics personnel assisted SAC crews in the first several launches but the Air Force crews encountered difficulties when they began launching the missile unassisted. Project Golden Ram (AW Dec. 19, 1960, p. 25) then was initiated to simplify launch procedures and to give USAF crews a greater familiarity with the weapon system.

Like GD/A crews at Cape Canaveral during Atlas' five-year flight test program there, SAC crews grew more proficient at Vandenberg with more experience. The results of the launchings were:

• Twenty successes—12-D, Sept. 9, 1959; 6-D, Jan. 26, 1960; 25-D, Apr. 22, 1960; 99-D, Dec. 16, 1960. First Golden Ram launch (AW Dec. 26, 1960, p. 24), 95-D, May 24, 1961; 101-D, Aug. 22, 1961; 53-D, Nov. 25, 1961; 82-D, Dec. 6, 1961; 123-D, Jan. 17, 1962; 132-D, Jan. 23, 1962; 137-D, Feb. 16, 1962; 66-E, Feb. 28, 1962. Launched from operational type facility; 134-D, Mar. 23, 1962; 129-D, Apr. 11, 1962; 140-D, Apr. 27, 1962; 127-D, May 11, 1962; 141-D, July 12, 1962. Flown 6,111 naut. mi. into Philippine Sea; 13-D, July 19, 1962. First Nike Zeus target vehicle; 8-D, 87-D, Aug. 9, 1962. First multiple launch.

• Five partial successes—74-D, July 22, 1960; 47-D, Sept. 12, 1960; 33-D, Sept. 29, 1960; 27-E, Jan. 7, 1961. First Atlas E fired from coffin; 67-E, July 13, 1962. Test of facility system.

• Four failures—23-D, May 6, 1960; 81-D, Oct. 12, 1960; 52-D, Feb. 21, 1962; 64-E, Dec. 18, 1962.



"Your tube delivery requirement may not be as tight as the one we had for White Sands recently, but if it is, we'll meet it. White Sands needed a special klystron, and they needed it fast. We got the order on a Tuesday, about nine in the morning. By three in the afternoon, the tube was in the air on its way to White Sands. Just 24 hours after it was ordered, this klystron was installed and operating. A special case, of course; but we'll treat *your* special case exactly the same way." *Tom Fitzsimmons, Supervisor, Customer Services, at Varian's Palo Alto Tube Division.*

TUBE DIVISION, *Palo Alto, California* | VARIAN ASSOCIATES OF CANADA, LTD., *Georgetown, Ontario*
BOMAC DIVISION, *Beverly, Massachusetts* | SEMICON OF CALIFORNIA, INC., *Watsonville, California*
S•F•O LABORATORIES, INC., *Union, New Jersey* | SEMICON ASSOCIATES, INC., *Lexington, Kentucky*

MICROWAVE TUBE GROUP VARIAN associates

believe that the missile's fuel and liquid oxygen drains failed to close properly and that leaking propellants mixed in the hot environment of the thrust section. Explosion followed, damaging and releasing the booster section. Range safety officer destroyed the missile 10 sec. later.

The next two D-series missiles 7-D, launched May 18, 1959, and 5-D, launched June 6, 1959, exploded after one minute of flight and after staging of the booster engines, respectively. Rough engine combustion was suspected in both cases. First successful D series flight was 11-D, July 28, 1959. When another successful flight followed on Aug. 11, 1959 with 14-D, Air Force scheduled a critical test of the weapon system—a launching conducted by a Strategic Air Command crew from Vandenberg AFB, Calif.

Atlas 12-D was programed for this first SAC training launch. With GD/A personnel in the blockhouse to help if necessary, the SAC crew successfully launched 12-D on Sept. 9, 1959, on a 4,500 naut. mi. flight into the Pacific Ocean.

Immediately after the launch, USAF announced that Atlas was now operational, although the force totaled only two missiles erected in research and development type gantries at Vandenberg. A third Atlas later was erected in the gantry from which 12-D had been launched, after the stand had been repaired from the damage caused by launching.

"It was declared operational," one engineer said, "when Air Force thought it [Atlas] had a reasonable chance of meeting its objectives. But the weapon system was not yet perfected."

C series having proved that the Atlas could be flown close to populated areas with safety, GD/A swung the downrange trajectory of D-series missiles at Cape Canaveral over to a more southeasterly bearing and began aiming the vehicles into the MILS net at Ascension Island. This net is a pentagonal array of hydrophones, several miles on a side, with a hydrophone in the center. Splash of the re-entry vehicle hitting the water and detonation of a Sofar bomb carried in the nose cone give different sound-intensity readings at the six hydrophones. Knowing the propagation of sound in water, GD/A then could calculate impact of a cone within ¼ to ½ naut. mi. of actual splash.

Immediately after USAF's announcement that the weapon system now was operational on the West Coast, GD/A launched seven consecutive D-series missiles (17-D, 18-D, 22-D, 26-D, 28-D, 15-D and 31-D) into the MILS net. Three of the next four Atlas Ds (40-D, 43-D and 49-D), were successfully flown beyond MILS net to a distance of 5,500

naut mi., where ships recorded the impact of their re-entry vehicles. The fourth of this group, 44-D, was successfully flown 4,400 naut. mi. into the MILS net.

Two of the three longest ballistic flights yet made by the United States were with the D series. Both 56-D and 79-D were flown about 7,860 naut. mi. into the Indian Ocean off the southeast tip of Africa. Atlas 22-E, guided by the Arma all-inertial system, traveled 7,874 naut. mi. on July 6, 1961.

Both the GE Mk. 3 and the heavier Avco Corp. Mk. 4 re-entry vehicles were flight-tested aboard Atlas Ds. With either one the Atlas D on several occasions exceeded the 5,500-naut.-mi. range. Weight of the D series airframe and of all airborne systems was reduced beyond the original design when GD/A's experience with the A, B and C series revealed that these improvements could be made safely. This over-all improvement, plus improvements in the Rocketdyne engines, was translated into greater range and heavier warheads.

Seven Atlas Ds (42-D, 48-D, 54-D, 60-D, 66-D, 76-D and 71-D) flew the Arma all-inertial guidance system for evaluation purposes preparatory to E-series testing. The first flight was conducted open- and the last six closed-loop.

Space Boosters

Atlas D series also were the first of the General Dynamics built missiles to be used as space boosters both by USAF and the National Aeronautics and Space Administration. Air Force also used D series to train SAC crews (see box p. 69).

Results of the Atlas D-series tests:

- **27 successes**—11-D, July 8, 1959; 14-D, Aug. 11, 1959; 17-D, Sept. 15, 1959; 18-D, Oct. 6, 1959; 22-D, Oct. 9, 1959; 26-D, Oct. 29, 1959; 28-D, Nov. 4, 1959; 15-D, Nov. 24, 1959; 31-D, Dec. 8, 1959; 40-D, Dec. 18, 1959; 43-D, Jan. 6, 1960; 44-D, Jan. 26, 1960; 49-D, Feb. 11, 1960; 42-D, Mar. 8, 1960; 56-D, May 20, 1960; 54-D, June 11, 1960; 62-D, June 22, 1960; 27-D, June 27, 1960; 60-D, July 2, 1960; 32-D, Aug. 9, 1960; 66-D, Aug. 12, 1960; 76-D, Sept. 16, 1960; 79-D, Sept. 19, 1960; 71-D, Oct. 13, 1960; 55-D, Oct. 22, 1960; 83-D, Nov. 15, 1960; 90-D, Jan. 23, 1961.
- **Two partial successes**—7-D, May 18, 1959; 5-D, June 6, 1959.
- **Three failures**—3-D, Apr. 14, 1959; 51-D, Mar. 10, 1960; 48-D, Apr. 7, 1960.

The 18 Atlas E-series missiles flown from the Cape were production-line weapons, differing from those Es delivered to SAC missile bases only in the addition of test instrumentation. E-series, is emplaced horizontally at operational bases in semi-hardened coffins. It must be erected to the vertical and fueled before launching and normally carries the Avco Mk. 4 re-entry vehicle.

E series was the first Atlas powered by the Rocketdyne MA-3 propulsion system, which has a total of 389,000 lb. of thrust. Sustainer engine and two verniers remained fairly constant throughout at the flight test program at 57,000-lb. and 1,000-lb. thrust each, respectively. Boosters were constantly uprated. A series had the MA-1 engines, producing 150,000 lb. thrust each. B, C and D series had the MA-2 package, developing 155,000 lb. thrust each.

MA-3 Engines

Each booster engine in the MA-3 design, used on the F series as well as the E-series, developed 165,000 lb. thrust. In addition, MA-3 boosters contained separate and independent turbopumps and propellant-feed lines. MA-1 and MA-2 booster engines shared a common pump and lines. MA-3 engines, in addition to being designed for greater accessibility and maintainability, also lacked the rough combustion cutoff (RCC) device of earlier series. This device was used to shut down a rough-burning powerplant during the several seconds hold-down time after engine ignition and save a research and development vehicle before it had been committed to flight. It is of no use to an operational weapon.

E series also was the first Atlas to carry the square autopilot instead of the round units flown until then. So-called because of the external configuration of their enclosing canisters, the square unit was miniaturized and mostly solid-state; the round autopilot included a number of vacuum tubes.

The E series missile encountered some engineering problems, mostly in the sustainer engine's hydraulic flight control system. First two Atlas Es flown from the Cape suddenly lost hydraulic pressure at BECO and, consequently, the ability to gimbal the sustainer engine. They were rated as partial successes.

Trouble was believed to have centered around the use-off valve, a poppet

USAF Training at Cape Described

Cape Canaveral, Fla.—All-USAF crews launched the last five Atlas research and development missiles flown from here during the weapon's five-year flight test program. Crews were from 6555th Aerospace Test Wing, a unit of Air Force Systems Command's Ballistic Systems Div. stationed here at the Air Force Missile Test Center. Purpose of the launchings was not so much to train crews in use of the Atlas weapon system as it was to develop a research and development launch capability for USAF here at this national range.

Air Force Chief of Staff Curtis LeMay, then vice chief of staff, is said to have directed Air Research and Development Command, forerunner of Systems Command, in 1960 to develop its own launch capability on the Atlantic Missile Range and not to rely exclusively on contractors for this service. Some observers believe the reason was concern that the National Aeronautics and Space Administration, which launches its own vehicles from the Cape, could become the dominant government agency on the Atlantic Missile Range if USAF lacked the capability to fly its own vehicles. The directive applies to the Titan 2, Titan 3 and Minuteman projects as well as Atlas.

USAF began placing personnel among General Dynamics/Astronautics crews in mid-1960 on the four Atlas launch stands at the Cape—11, 12, 13 and 14. When stands 12 and 14 were converted for space missions, this training continued on stands 11 and 13, the former used for F-series Atlases and the latter for E-series.

USAF personnel were phased into all elements of GD/A's Cape Canaveral operation—checkout, erection, maintenance and launch—on a man-by-man basis, as they became available. This process was completed by mid-1962.

Atlas 11-F was the last missile scheduled to be launched by GD/A. It blew up on stand 11 Apr. 9, 1962. Members of Air Force's Atlas Launch Operations Team of the 6555th participated in the rehabilitation of the stand and, according to a project officer, "learned a lot more about the CSE [ground support equipment] than they would have otherwise."

This team, numbering about 13 officers and 107 men, including a blockhouse crew of about 25 personnel, is under the over-all direction of Maj. Jack F. Pierce. Team made five consecutive successful launches of the F-series missile: 7-F, Aug. 13, 1962; 8-F, Sept. 19, 1962; 14-F, Oct. 19, 1962; 16-F, Nov. 7, 1962; and 21-F, Dec. 5, 1962. Test conductor for these launches was USAF Capt. Robert L. Borland.

6555th officers illustrate the competence developed by the Atlas Launch Operations Team by citing T/Sgt. Cary B. Faile's work in replacing an entire re-entry vehicle on Atlas 21-F in 102 min. Because of photographic requirements, 21-F had to be launched no later than 4:30 p.m. EST on Dec. 5. Early in the countdown, a no-go condition developed in the Avco Corp. re-entry vehicle. When it was determined that the condition could not be repaired on the stand but would necessitate de-mating, Sgt. Faile and his crew volunteered to replace the re-entry vehicle with a spare nose cone. The job was completed in time for a 4:25 p.m. launch.

Polaris: the first six years

It was January, 1957, that the U.S. Navy first announced its plans for a completely new kind of ballistic missile — and chose Lockheed Missiles & Space Company to build it. The six years since then have witnessed the swift evolution of Polaris from idea to mainstay of the nation's deterrent force.

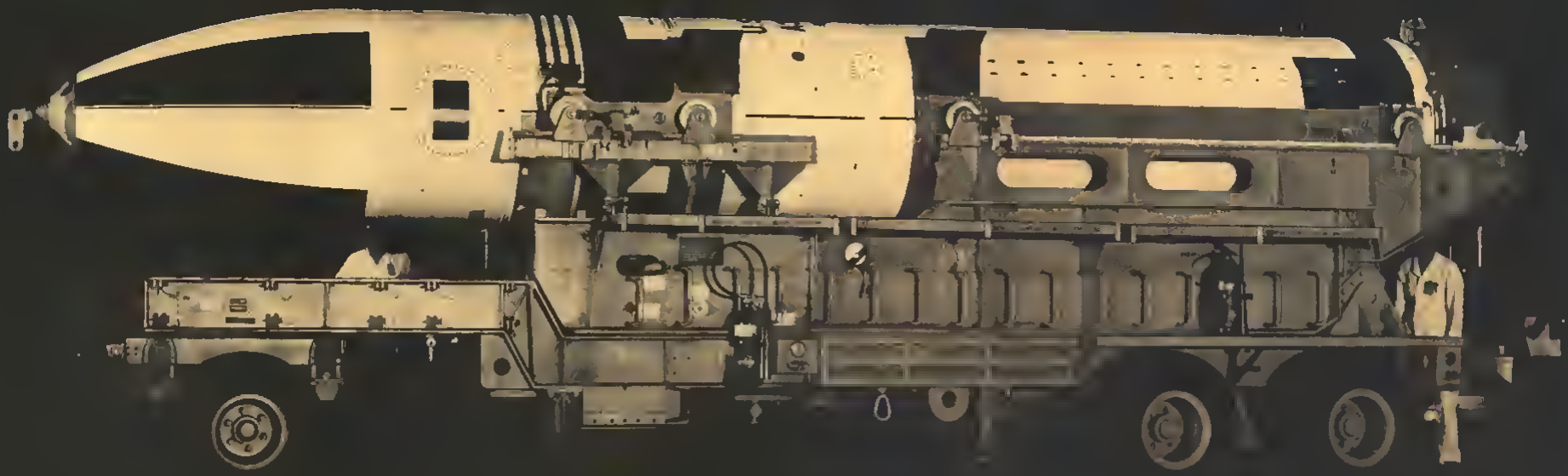
Of equal significance is the revolutionary new method for speeding weapon systems to operational status that was born of the close-knit partnership between the Navy's Special Projects Office, Lockheed, and the entire contractor team. One requirement the new method took in stride was that the Polaris missile itself be increased in both size and range as the program developed. When the first submarine armed with the 1200-mile A-1 Polaris went on patrol in November, 1960, the 1500-mile A-2 was already in advanced flight test. The A-2 has now been in production more than a year. The 2500-mile A-3 will join the fleet in mid-1964.

Polaris is a versatile missile. Compact, easy to transport, and extremely reliable, it can be launched from surface ships — or, by remote control, could be launched from the floor of the sea. Today the Navy-Lockheed team is prepared to meet whatever new challenges lie ahead for Polaris.

Lockheed

Lockheed Missiles & Space Company, Sunnyvale, California • A Group Division of Lockheed Aircraft Corporation

The A-3 Polaris, shown below on its transporter-erector at Cape Canaveral, is now in flight test.



valve in the airborne hydraulic flight control system. Prior to launch a mechanical finger in the launch stand keeps this valve open so that the missile may draw hydraulic fluid from the ground storage tank. At the moment of launch, this poppet leaves the finger and closes sealing the hydraulic system for flight.

Believing that the new uprated MA-3 powerplant was creating a different—and possibly more severe—temperature, shock and acoustic environment in the engine compartment, GD/A engineers suspected that the previously trouble-free valve was sticking open and that hydraulic fluid was leaking out during booster operation. By the time BECO occurred, there simply was no more hydraulic fluid remaining to drive the sustainer around its gimbal block.

Atlas 12-E was instrumented with a dummy rise-off valve and telemetry data later indicated that, as suspected, it was sticking open. Problem was solved by placing a unidirectional flow valve upstream of the poppet and wrapping additional insulation around hydraulic lines.

E-series also proved that the missile industry is not immune to Murphy's Law—to which the aircraft industry has long been subject. Murphy's Law states that if a part can be installed backward sooner or later someone will install it that way. Atlas 16-E launched Mar. 24, 1961, had no part as such installed backward but a technician did reverse the wiring for vernier engine ignition and vernier tank pressurization.

Verniers used for final velocity adjustments after sustainer burnout and before nose cone separation, normally are ignited at liftoff along with the three main engines. During booster operation these two 1,000-lb. thrusters are fed with oxidizer and RP-1 fuel from the main propellant tanks. Prior to BECO, two small spherical tanks at the base of the Atlas airframe are filled with liquid oxygen and fuel. This assures the verniers of propellants to draw on, should the three main engines totally deplete the vehicle of liquid oxygen and RP-1 during their burning. At BECO the same high-pressure gas which initiates the booster jettison process also pressurizes these small vernier tanks.

Because the eccentricity was reversed however the pressurization system was activated at liftoff and the gas flowed through the empty vernier tanks and then overboard through the main thrusters. Verniers came on with a bang at BECO, but there was insufficient gas pressure to jettison the boosters. Because of Murphy's Law Atlas 16-E was listed as a partial success.

Results of Atlas E-series tests were:

- Ten successes—9-E, Feb. 24, 1961, 12-E, May 12, 1961, 18-E, May 26, 1961, 22-E, July 6, 1961, 23-E, July 31, 1961, 25-E, Oct. 2, 1961, 30-E, Oct. 5, 1961, 35-E, Dec. 1, 1961, 36-E, Dec. 19, 1961, 40-E, Feb. 13, 1962.
- Six partial successes—3-E, Oct. 11, 1960, 4-E, Nov. 29, 1960, 8-E, Jan. 24, 1961, 13-E, Mar. 13, 1961, 16-E, Mar. 24, 1961, 26-E, Sept. 8, 1961.
- Two failures—17-E, June 22, 1961, 32-E, Nov. 10, 1961.

Atlas F-series is almost an identical twin to the E-series but differs in the method of emplacement. It is meant to be stored in a concrete silo and raised to the surface by elevator for launching. Because it is stored with a full load of RP-1 at all times it is fitted with pre-valves in the fuel lines leading to the engines to preclude leakage. This essentially is the only difference between the E- and F-series.

The 10 Atlas Fs flown from Cape Canaveral and the three Atlas Fs flown from Vandenberg AFB, Calif., were aside from concern about the possibility of a booster engine bumping the sustainer during jettison (see above) generally smooth and trouble-free.

Results of the Atlas F-series:

- Seven successes—2-F, Aug. 8, 1961, 4-F, Nov. 22, 1961, 7-F, Aug. 13, 1962, 8-F, Sept. 19, 1962, 14-F, Oct. 19, 1962, 16-F, Nov. 7, 1962, 21-F, Dec. 5, 1962.
- Two partial successes—5-F, Dec. 8, 1961, 6-F, Dec. 20, 1961.
- One failure—11-F, Apr. 9, 1962.

From Vandenberg the F-series missile was launched three times from an operational type silo test facility (Cape Canaveral has only gantries), with two successes (15-F, Aug. 1, 1962 and 13-F, Nov. 14, 1962) and one failure (57-F, Aug. 10, 1962).

Experience gained by the General Dynamics/Astronautics crews at Cape Canaveral during five years of flight testing was evident in the decreasing amounts of hold time for each series. Holds can be ordered for any number of reasons—in either which obscures camera coverage—ships off the Cape—but generally are associated with difficulties which prevent the countdown from proceeding according to plan.

Each Atlas A missile averaged 3 hr. of holding time before launch. Each B-series missile ran a little more than 2 hr. of hold time. On C-series the figure dropped to 30 min. Average hold time for D-series was 90 min. with the E-series about the same. F-series ran 1 hr. of holding for each missile.

Increased hold times for D- and E-series reflect the greater number of first-order test objectives programed for these series. For example if telemetry were suddenly lost on the re-entry vehicle of a D, E or F series Atlas the countdown would have been stopped and the problem investigated. The missile would not be launched until that link was re-established. If however the telemetry channel on the propellant utilization system was suddenly lost just a few seconds before ignition GD/A might have continued with the countdown as performance of this system might be a second order test objective on that particular flight.

Artist's Concept of Bell Lunar Research Vehicle

Artist's concept shows manned research vehicle to be built by Bell Aerosystems for National Aeronautics and Space Administration. Vehicle will be used to develop requirements for crew training devices for NASA-Grumman Lunar Excursion Module (LEM) portion of the Apollo program. Two vehicles are being built under $3.6 million contract, and will permit studies of piloting and operational problems involved in the final phase of a lunar landing and initial phases of lunar takeoff. Vehicles will carry one man and 200 lb. of research gear in two men with provisions for crew ejection seats in other configuration. Jet engine will be utilized for takeoff and to compensate for the earth's gravitational force.

Gemini to Be Used as Space Medical Lab

By Erwin J. Bulban

San Antonio, Tex.—Two-man Gemini spacecraft will provide a space laboratory facility of significant value for aerospace medical research compared with the short-duration one-man Mercury system. Dr. Stanley White told scientists attending the USAF aeromedical lecture series here at Bronks AFB. At the same time, he said Gemini will provide the physiological data necessary for design of Apollo equipment.

Report was prepared by Dr. White in collaboration with Dr. George B. Smith, Jr. Both men are with the National Aeronautics and Space Administration's Manned Spacecraft Center in Houston.

Gemini will have a 100% oxygen environment, pressurized at 5 psi, the report stated. Extensive tests have clarified the effects this type of atmosphere will have on astronauts during a long flight. Questions had been raised as to whether the atmosphere would increase calcium deposits in astronauts' urine, affect their vision, decrease their acceleration tolerance, cause middle ear pain or produce oxygen toxicity.

Tests of up to 14-days duration have shown no physiological reasons to prevent use of the 100% oxygen atmospheric environment. Some subjects showed a variety of effects, but these proved to be individual subject tolerances rather than basic problems.

One test subject reported a deterioration in lateral vision after a test, but said he maintained good forward vision. The effect lasted about 24 hr.

There was a decrease in blood hemoglobin of about one gram in four or five subjects. One subject had a drop of 5 grams—from a normal of 14 grams to 9 grams—but he later was found to have a latent inherited anemia.

Full results of the NASA study will be presented in May at the annual meeting of the Aerospace Medical Assn.

Requirement calling for a system which would permit an astronaut to move outside the spacecraft during the two-day rendezvous mission has had a major impact on the suit and environmental system designs.

Methods for checking fittings to assure positive connections and sealing of the suit after dressing in flight must be incorporated to prevent injury to the astronaut. Gemini suit has disconnects at helmet, arms and lower legs which will have to be sealed. A pressure-check system is being designed for use prior to cabin depressurization and exit of the astronaut.

Use of a personal life support system (PLSS) to provide oxygen while the astronaut is outside the orbiting spacecraft is being considered.

Back-up system in the form of an umbilical cord or hose connected to the spacecraft also is being studied. If the umbilical cord is chosen for Gemini the suit must have circuit dynamics that can compensate for changing pressure drop caused by varying lengths of hose. Hoses probably would be stored under the seats.

Study of exact metabolic needs of the astronaut will be a significant part of the Gemini flights. This will include obtaining quantitative data on effects of oxygen consumption on body waste and perspiration. Diet of 2,550 calories per man is planned for Gemini. Water for metabolic use is planned at the rate of 6.5 lb. per man per day.

Studies will include:

- **Determination and understanding of** what is "normal" physiological data.
- **Means of juggling or varying** metabolic handling of the astronauts during the course of long flights. Metabolism can be controlled by varying different environmental factors, including diet and atmosphere content.
- **Interplay of cardiovascular** and respiratory systems.
- **Definition of rest and work cycles.**

These studies will attempt to determine the exact metabolic needs of crews on Apollo flights.

Dr. White also indicated that the Russians have not done much study on these aspects and have been extremely interested in U.S. tests on metabolism.

Cosmonauts' Calcium

San Antonio, Tex.—Russian space scientists noted a surprising increase of calcium in the urine of their cosmonauts in the third or fourth day of the Nikolayev-Popovich dual spacecraft mission, Dr. Stanley C. White of the National Aeronautics and Space Administration's Manned Spacecraft Center in Houston stated here.

Condition may be caused by lack of exercise in a zero-g environment, where, due to lack of interaction of bones there is immobilization of normal calcium replacement of bone structure. In extreme cases there may be demineralization of the bones. There is a possibility that the Russians experienced the condition because of the lack of suit mobility due to their use of the relatively high suit pressure of 7.5 psi to avoid "bends."

Body cleanliness and personal hygiene equipment is under study, although final selection of equipment has not yet been made. Methods of cleansing the body of perspiration and body waste residues and suppressing bacterial counts by chemical cleansing agents are being evaluated.

Problems here are to obtain materials that will not present toxicity problems in the high oxygen content atmosphere and will not cause skin irritations.

Electric razors for shaving must eliminate possibility of combustion or explosion through sparking in this atmosphere and also must provide efficient stubble collection to prevent small hairs from contaminating equipment or from floating about in a weightless environment and creating a nuisance.

Ability of crew members to partially undress will permit the use of more standard clinical approaches in gathering body-system data. One crewman can serve to obtain physiological data on the other. Periodic samplings of body fluid can be gathered in this manner, thus eliminating the need to rely on more complex electronic systems.

Other lectures given during the meeting detailed a variety of other work being undertaken.

Space "broom" that could artificially sweep away trapped radiation zones was hypothesized by Alan Rosen of Space Technology Laboratories Space Physics Dept. Rosen theorizes that if it were possible to loft a broom with an area of approximately 1 million square meters co-planar with the equatorial plane of the earth and move it radially from an altitude of 100 km. to 5,100 km., it could absorb or deflect all protons greater than 20 mev. in approximately 35 days. Broom might be an aluminum plate-type surface or a large balloon.

The power to move such a surface through a constantly changing, spiral orbit is far beyond current capabilities, Rosen acknowledged. A smaller similar mechanism, on the order of 100 square meters, would take 1,000 years to do the job, he said.

Rosen also noted that the lifetime of the artificially injected electrons created by a one-megaton explosion last July 9 over Johnston Island in the Pacific may be years. These electrons, which have a greater maximum intensity than those found in the ambient environment, form a greater hazard to low-orbiting manned space missions than did the original radiation environ-

ment found in the vicinity of the inner Van Allen radiation belt. Rosen stated that the next large-scale experiments similar to the artificial injection experiments may have as their objective the scattering of particles from the trapped radiation zones and possibly sweeping out these particles completely.

Initial Mariner data indicates a significant lack of meteoroids both in interplanetary space and near Venus, R. J. Parks of Jet Propulsion Laboratory noted. Mariner's micrometeoroid detector counted only a few hits indicating a density of one part in 10,000 in the vicinity of Venus.

Radiation exposure also was low, approximately three Roentgens during the 109-day flight. One quarter of a Roentgen of this total was from a minor (Class 2) solar flare.

There was no appreciable change in radiation count during the Venus flyby and indications are that there is no equivalent to the earth's Van Allen radiation belt near Venus.

Gravitational Pull

Gravitational pull of Venus on Mariner caused an inward flight path deflection proportionally of the same order as would be experienced on a similar-distance flyby of earth, Parks reported.

Radiation of 600-700F heat from Venus' light side caused temperature rises on some equipment that was higher than it had been possible to simulate in the laboratory prior to the actual flight. The spacecraft's batteries had a temperature rise to 130F during flyby—close to their upper limit.

Parks considers that one of the significant aspects of the flight is the large amount of environmental data that is being obtained. This data will aid spacecraft designers in calibrating environmental laboratory testing gear to check out spacecraft for future flights.

Mariner has provided approximately 100 million bits of data in its Venus mission, and indications are that the time required to translate this information and cross-check its meaning will delay release of information planned for next month, to a later time.

Crew confinement testing utilizing a crew-station simulator containing five crew positions a small leisure area and sleeping quarters—a total volume of 1,100 cu. ft.—indicated that the most favorable work-rest cycle for long duration space flights was four hours on and four off.

Subjects who underwent thirty-day missions simulated in the facility, operated for the USAF by Lockheed-Georgia, indicated they could have carried on indefinitely with this cycle. Similar testing also indicated that a four-hour work period followed by two hours rest, would be acceptable for space missions up to 15 days duration.

Walter Grether, Aerospace Medical Research Laboratories, Wright-Patterson AFB, noted that the Behavioral Sciences Laboratory of AMRL now has a centralized space training facility study under way, which is examining the most promising USAF military space systems to review in detail the functions and tasks USAF personnel most likely will perform. Study will attempt to determine the facilities needed to train crew members.

Tests by AMRL in crew movement in a spacecraft in a zero gravity environment, utilizing Convair C-131 and Boeing C-135 aircraft flying parabolic trajectories indicate that the best means of locomotion in this environment is to free float from place to place, using the feet and hands for propulsion and hand holds to provide guidance.

Study of various types of special footgear, including magnetic shoes, suction cup footgear and shoes and surfaces coated with a hook-and-eye material, show that simple adhesion is not an adequate gravity substitute for walking.

Grether appeared to concur with other specialists studying physiological problems of man in space that the need for artificial gravity devices, such as rotation of the spacecraft to overcome weightless effects, probably will diminish rapidly as actual experience is gained in this environment. Engineering problems involved in producing such devices probably will outweigh the requirements for lightweight, reliable systems, he indicated.

Schirra Leg Condition

San Antonio, Tex.—Pooling of blood (orthostatic-hypotension) noticed in legs of MA-8 Astronaut Lt. Cdr. Walter Schirra in post-flight medical examination will be studied in future flights to see if it constitutes a problem. But Dr. Stanley C. White, of the National Aeronautics and Space Administration's Manned Spacecraft Center in Houston, emphasized that Schirra showed no degradation of his performance either in flight or afterward. Condition is similar to that experienced by patients who try to walk after several days in bed. Dr. White indicated here that should this turn into a problem, a pulsing cuff to stimulate circulation might be used.

Dr. Robert B. Voas, of MSC, said that it could not be determined when the temporary condition occurred and suggested that perhaps it was noticed in Schirra because his flight was longer than the previous flights and also because he was retrieved and examined sooner than the earlier astronauts. Dr. Voas emphasized that by this time there was nothing relating to this orthostatic hypotension experience that would disqualify Schirra for further flights.

'Blue Gemini' Missions Outlined by USAF

San Antonio—First-generation (Mark 1) two- to four-man orbital development station for space research is under study by USAF as part of its "Blue Gemini" planning (AW Dec. 10, p. 27).

Air Force apparently is confident that the Gemini and space station programs can be merged into a single broad development and training Blue Gemini project. USAF recently signed an agreement with National Aeronautics and Space Administration (AW Jan. 28, p. 26) in which Air Force was made an active participant in the Gemini program. Blue Gemini at this time remains in the conceptual phase, and has not been approved for development or hardware. Air Force however, is hopeful that its Gemini participation will lay the groundwork for a Blue Gemini program.

Both spacecraft—Gemini and the manned orbital development system (MODS)—might be lofted into orbit simultaneously by a Martin Titan 3 launch vehicle in late 1965 or early 1966.

Initial objectives of the Gemini-MODS program would be to provide a space station for carrying out biomedical research (see p. 79) for periods beyond the normal two-week orbital mission capability of Gemini. To meet this goal, provision would be made for rendezvous with follow-up Gemini spacecraft and personnel transfer. Such transfers probably would be conducted through egress panels in the Gemini heat shield.

Mark 1 Gravity

Although the Mark 1 MODS might initially be operated in the weightless state, there may also be provisions for subsequent intermittent or continuous artificial gravity.

Maneuver capability to permit "Blue Gemini" spacecraft to inspect uncooperative satellites (AW Jan. 28, p. 26) might be obtained by adding a transtage to the rear of the Gemini. Gen. O. J. Ritland, deputy commander of USAF Systems Command, indicated this possibility recently while attending the annual aerospace medicine lectures sponsored by the School of Aerospace Medicine at Brooks AFB here.

Fuel requirement to provide maneuvering capability in earth-orbit is on the order of half the satellite mass to rotate the orbital plane 17.8 deg. at a 200-naut. mi. circular orbit, Gen. Ritland noted.

To phrase the problem in more familiar terms, he pointed out that a modern jet fighter moving at 700 mph. can execute several hundred turns of about 15 deg. using fuel equal to half its weight. But a spacecraft traveling at 18,000 mph., he noted, could execute only one such turn using present chemical propellants—or three such turns with high-energy nuclear propellants. Similarly, a chemically fueled spacecraft would consume half its mass in fuel in transferring from a circular orbit of 200-naut. mi. altitude to a circular orbit of 4,400 naut. mi., utilizing the Hohmann transfer maneuver, in which a velocity increment is added to the satellite velocity in the direction of motion followed by coast in an elliptical orbit to apogee, at which time another velocity increment is added to the satellite velocity to project the spacecraft into a circular orbit at the higher altitude.

USAF "Blue Gemini" plan envisions a half-dozen of the spacecraft to begin missions in 1966 on objectives including biomedical research, operational training and rendezvous training. Further extension of "Blue Gemini" requiring additional spacecraft could be made at almost any time in this program because of lead-times of only 14-15 months in procuring additional units.

Other highlights of the aeromedical lecture series here:

- **About 1,800 potential** anti-radiation drugs are being evaluated by laboratories of the Atomic Energy Commission and Defense Dept., and the work offers "great promise," according to Maj. Gen. R. L. Bohannon, USAF deputy surgeon general. He noted that radiation damage depends upon the doses and type of radiation, the time interval over which the exposure occurs, part of the body affected, age and health.

Gen. Bohannon said that studies show a cell is more vulnerable to radiation damage if it has an above-normal concentration of oxygen. Thus the cell is protected by hypoxia. Stimulating the production of white cells protects the cells, and slowing metabolism also protects against radiation damage to some degree. He added that the Soviets have reported that their cosmonauts have been protected from the harmful effects of radiation with a special "chemical preparation," which has not been identified.

- **Main problem** facing the U.S. in gathering space biomedical data is in miniaturization of equipment and improving methods of obtaining telemetry data. Equipment now used consists largely of adaptations of clinical-type gear and is still too bulky. A program is under way to eliminate the present blood pressure cuff, which aside from its bulkiness, presents the problem of distraction during operation. A possible substitute under consideration is pulse-wave velocity equipment which would measure the speed of the blood pressure wave from the heart to a predetermined point on the astronaut's arm, where an electrical pickup would be located.

Gen. Bohannon noted that the Russians are working on the idea of using the electrical potentials of the brain (electroencephalogram) as a signal to warn of the approach of a critical state of acceleration effects and possibly actuate a protective device. U.S. concepts in the instrumentation field generally call for monitoring and controlling the environment and transmitting data on the pilot's physical condition. It probably will be some time before approaches will be made to monitor and control the astronaut's physiological condition by installing pickups that will automatically trigger devices or drugs to overcome the problem.

- **Physical standards** for missile site duty have been reviewed and tightened. Earlier selection standards apparently did not adequately detect some defects. An example of this was a launch control officer who had a color identification deficiency of such a nature that he had been able to distinguish colors in a B-52 simulator but was unable to identify colors on a missile launch console. He was reassigned.

Job Dissatisfaction

Some personnel have complained of pains after assignment, but the symptoms were later shown to be attributable to job dissatisfaction. Such cases have been noted particularly among former flight crews, who had been assigned missile duties on a non-voluntary basis. 'Silo anxiety" problems may increase with the addition of large numbers of Minuteman solid-fueled ICBMs to the USAF inventory. Only two launch control officers are required per weapon, and their quarters are smaller than those of control officers for earlier liquid-fueled systems.

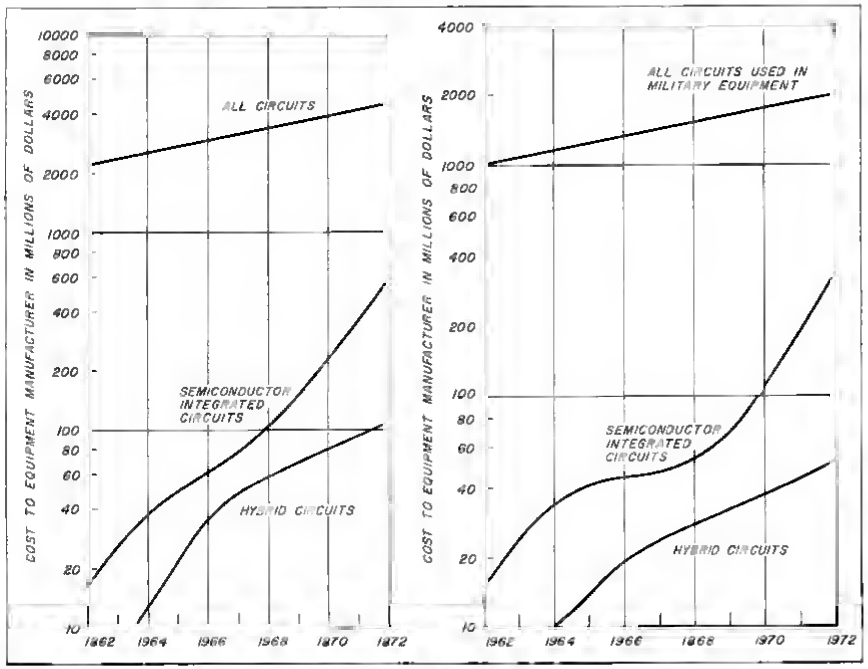
Grants for Colleges Increased by NASA

Washington—Greatly expanded predoctoral training program has been announced by the National Aeronautics and Space Administration for the 1963-64 academic year, with 800 grants scheduled in 88 colleges.

Program began last year with 100 grants to students of 10 colleges.

Candidates will be selected by schools and will receive $2,400 annual stipends with $1,000 allowances for dependents.

Universities will be paid the costs of administering the program.



SALES PROJECTIONS for semiconductor integrated circuits and hybrid circuits using thin-film passive elements are plotted over the decade and compared with the entire electronic circuit market in Fig. 1 (left). Sales estimates for both types of circuits to military and aerospace markets are shown in Fig. 2 (right). Total aerospace/military market in 1972 is projected to exceed $400 million for these types of circuits. Graphs were prepared by Arthur D. Little, Inc., as part of a year long research investigation

Study Forecasts Microcircuitry Growth

By [illegible]

Avionics manufacturers who supply equipment and systems for military and aerospace applications will be the largest single user of microcircuits during the next decade, according to a one-year research program recently conducted by the engineering consulting firm of Arthur D. Little, Inc.

Microcircuitry will penetrate industry in an evolutionary manner with its greatest use occurring in the latter half of the decade ending in 1972. The impact of these devices on the entire electronics industry will be less significant than that created by the widespread introduction into electronics equipment of semiconductor devices in the 1955-60 period. These are conclusions of a Little report on the research program [illegible] appraisal for Management Planning."

The $350,000 program was undertaken by Little with financial backing of seven aerospace companies comprising those of the Douglas Aircraft Astronautics Division of North American Aviation, Texas Instruments, Raytheon and Philco.

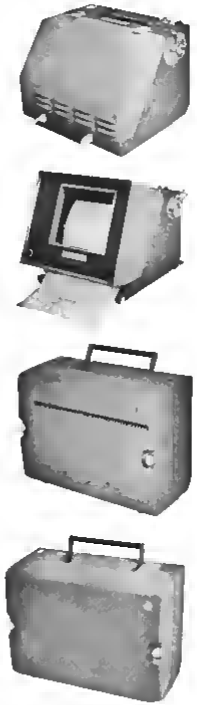
Its objectives were to forecast the economic and business implications of integrated circuitry over the next three to five years and to outline anticipated changes in character and structure of companies in the affected quarters of the electronics industry. In addition, it made a 10-year forecast of the nature and timetable of broad changes caused within the industry by the use of integrated circuits.

In a more general sense, the report [illegible] research, development, marketing, manufacturing and investment plans.

Little's study is a more ambitious effort than a somewhat similar one conducted by Stanford Research Institute and financed by eight avionics companies (AW Dec. 10, p. 95). The Little report's findings are detailed in a three-volume report containing a mass of technological economic and management data relating to microcircuits.

To avoid the confusion in terminology common in this field, Little defines an integrated circuit as an electronic circuit or subcircuit in which the component functional parts are produced integrally with and are inseparable from the whole. A semiconductor integrated circuit is one made on a semiconductor substrate by dif-

Record Magazines for CEC's 5-119V



Here are 3 types of record magazines CEC's versatile 5-119 Oscillograph can accept. DATARITE Rapid Access Automatic Processing Magazine for data in three minutes (or 3 seconds with the DATAFLASH cover). 5-051 Direct Writing Slot Exit Magazine for oscillograms on standard print-out paper with no processing necessary. 5-006 Standard Record Magazine for conventional-type oscillograms (records processed after the record run). Further data? Call CEC, or write for Bulletin CEC 5119-X14.

fusion, epitaxy or other processes common in transistor or diode fabrication. A thin film integrated circuit is one made of thin films, including thin-film active devices. A hybrid circuit is one consisting of a partially integrated circuit in combination with discrete components; a thin-film hybrid being a thin-film integrated circuit that uses discrete semiconductor active elements in place of the thin-film active devices not yet generally available.

Use of semiconductor integrated circuits will materialize in quantity during 1967-72.

Present use is, for the most part, confined to devices for test, evaluation, prototype production and research and development.

By 1972, the Little report estimates, the market for semiconductor integrated circuits will approach $600 million but will account for only 12% of a predicted total circuit market of $4.5 billion as shown in the projections of total use of integrated and thin film hybrid circuits as a function of time (see Fig. 1, p. 84).

Growth Pattern

This projection foresees thin film hybrid use growing over the decade but its position relative to semiconductor integrated circuits diminishing appreciably in the 1967-72 period. The difference between the two at the end of the decade is greater than it may appear at first glance since the ordinate (cost to equipment manufacturer scale) is logarithmic.

A measure of comparison of estimated markets predicted in the Stanford and Little reports can be inferred from Fig. 1. The market for semiconductor integrated circuits forecast for the year 1970 by Stanford was $778 million, while Little's projections place the figure at $310 million. Both organizations caution, however, that their estimates are based on judgments and as such should be subject to re-evaluation and possible revision.

But both of the studies apparently concur in general character, and in expectation that the period of major use will occur after 1967 and the likelihood that semiconductor integrated circuits will be the dominant type.

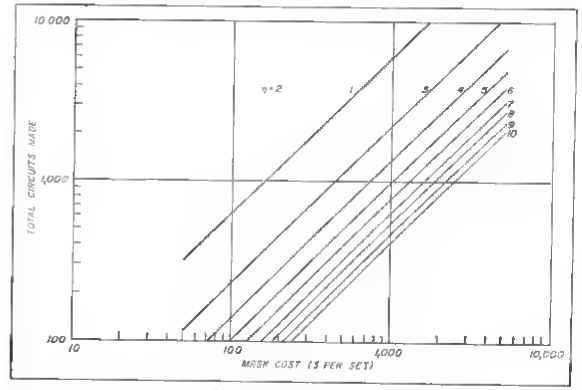
Military, Aerospace Use

Military and aerospace use of semiconductor integrated circuits will rise from $15 million in 1962 to $47 million in 1967 and $350 million in 1972, according to the Little report with large production use beginning in 1966-67.

This rise is shown graphically in Fig. 2 (see p. 84). The semiconductor integrated circuit market penetration, identified as the portion of total circuits converted to this type will be about 17% of the approximately $2.06-billion military equipment circuit market in 1972, calculations based on the graph show.

Thin-film hybrid circuits should account for $24 million in 1967 and $54 million in 1972, with an ultimate penetration of only 3% into military business the Little report estimates.

Commercial computer manufacturers will be the next largest user of integrated circuits during the next decade, accounting for $44 million in 1967 and $138 million by 1972. The 1967 integrated circuit volume will be divided



LINES OF EQUAL COST for semiconductor integrated circuits and thin film hybrid circuits are plotted as a function of mask cost for increasing number of transistors per circuit. Thin-film hybrid circuits are less expensive for any number of circuits which fall below the equal cost line, more expensive when the quantity of desired circuits is above the relevant equal cost line.

equally between semiconductor and thin film hybrids, according to the report. However, after a crossover in early 1968, the portion assumed by semiconductor integrated circuits will grow, reaching 70% in 1972. Penetration for both types combined will be about 16% in 1967 but may rise to 33% by 1972 (about $137 million of integrated and hybrid circuits in a combined commercial computer systems circuit market of $415 million).

Major Consumers

During the next three to five years, the major consumer of integrated and hybrid circuits will be applied research and development programs and test evaluations. Not until the evaluation of these programs is complete will their use become widespread. The chief motivation behind the use of semiconductor integrated circuits in military and aerospace applications the report says will involve factors of greatly improved reliability and reduction in long-term support, maintenance and logistic costs, with size and weight considerations secondary.

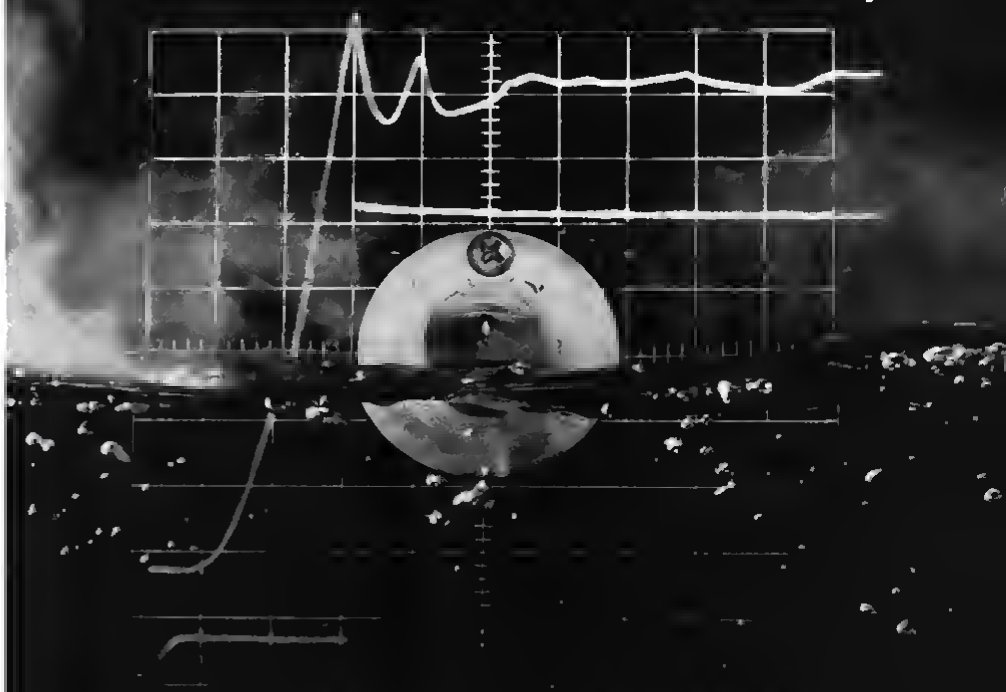
Motives for using thin film hybrid circuits also include reduced cost and improved reliability, but their promise is seen to be less than that of semiconductor integrated circuits. In addition, thin film hybrids outperform semiconductor integrated circuits in specific applications. While the advantages of potentially greater reliability are an important asset for the latter, the absence of conclusive reliability data in military systems and increasingly demanding Minuteman ICBM reliability levels may slow integrated circuit introduction.

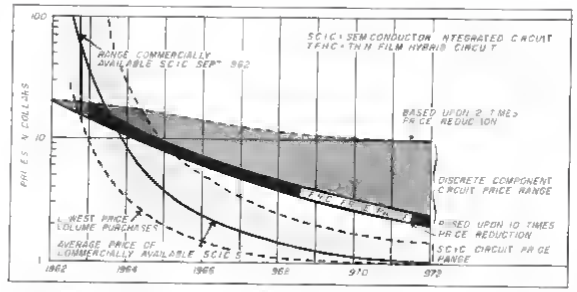
Five to seven year period between initial concept and production and operational use common to major systems, also will impede early widespread use of both hybrid and integrated circuits. And the cost of changing existing equipments may rule out use of the new circuits as retrofits even if they should show proven reliability and low cost. In recent months the Navy has begun partial introduction of integrated circuits on this basis, however.

Estimated Military Use

Estimated military use of semiconductor integrated circuits and hybrids for 1967 and 1972, according to Little, are as follows. For aerospace equipment:

- Aircraft—Semiconductor integrated circuits will account for $19 million in 1967, $55 million in 1972; thin film hybrids $4 million in both 1967 and 1972. Totals for the two years are $23 million and $59 million, respectively.
- Missiles—$11 million for semiconductor integrated circuits and $2 million for hybrids in 1967; $56 million and $4 million for the two categories in 1972.
- Spacecraft—$9 million for semicon-





PRICE PROJECTIONS are shown for equivalent circuits using conventional discrete components. Thin films or semiconductor integrated units. Semiconductor integrated circuit prices according to Arthur D. Little, Inc., which prepared the chart, will become increasingly competitive with those of discrete components later in the decade, with analog circuits being higher priced.

ductor integrated circuits and $1.5 million for hybrids in 1967, $110 million and $9 million, respectively, for the two categories in 1972.

Thus, the total projections for aerospace equipment in 1967 are $39 million for semiconductor integrated circuits and $7.5 million for hybrids, growing to $221 million and $17 million, respectively, in 1972 and ending in a combined $238-million total for aerospace integrated circuits and hybrids in 1972.

Other categories of military equipment using these circuits are:

• **Mobile equipment**, including mobile and shipboard communications, fire control, radar, navigation—In 1967 semiconductor integrated circuits will account for $2 million and hybrids $4 million, rising slowly in the next five years to $40 million and $17 million, respectively.

• **Fixed equipment**, including missile ground equipment, such as checkout gear—This market will be virtually nil in 1967 ($2.6 million for hybrids only), since principal advantages like reliability and maintainability add little to present fixed equipment and size and weight are relatively unimportant. By 1972, the Little report states, this may grow to $99 million for semiconductor integrated circuits and $20 million for hybrids.

• **Evaluation and test**—$6 million for semiconductor integrated circuits and $9.9 million for hybrids in 1967.

Earliest significant use of integrated circuits in military/aerospace hardware, according to the report, will be in airborne and missile digital computers and other digital avionics gear. This is because available integrated circuits can match requirements of this hardware now, and applied research programs are already under way to include these circuits in specific items of equipment (AW Jan. 14, p. 83).

Trend toward digital circuitry in avionics equipment may favor this approach. Emphasis on reduced size and weight in missiles will give added impetus to their use, but this may be delayed by stringent reliability requirements.

While the dollar market for integrated circuits in spacecraft applications may be large, much of this will be consumed by engineering and design costs in a field characterized by small volume and extensive testing. Lower power, savings in space, weight and improved reliability will be key factors aiding integrated circuits, the report states.

Use of analog integrated circuits, still in early development, and the virtual absence of realizable inductance in them, will limit their use in airborne communications until more of the latter switches over to digital circuitry, as is widely anticipated.

Other equipment, such as airborne radar, electronic countermeasures and reconnaissance gear, will become increasingly adaptable to integrated circuits, but their use will not become substantial until well after 1967 because of differences in the availability of integrated circuits that meet necessary performance requirements of this gear.

In evaluating the competitive capabilities of integrated, hybrid and discrete circuitry, Little researchers conclude:

• **Semiconductor integrated circuits**—These have a lower cost potential in large quantities than comparable circuits fabricated by other means. They hold promise still unproven, of higher reliability. While slower than circuits made with discrete transistors, their speed should become comparable in three years. The values of resistance and capacitance are less, and tolerances and temperature coefficients greater, than those of discrete components and thin-film circuits. Inductance is practically non-existent.

• **Thin-film integrated circuits**—In the absence of thin-film active components these do not exist except as passive element circuits which offer resistance and capacitance values, tolerances and temperature coefficients superior to those of semiconductor integrated circuits.

• **Thin-film hybrid circuits**—These are highly competitive with semiconductor integrated circuits, offer more design flexibility and are applicable where semiconductor integrated circuits are not. But they are more costly, except in small quantities.

• **Discrete component circuits**—During the next decade conventional assemblies with discrete components will continue to prevail for one or a number of reasons, including wide range of component values and tolerances, substantially lower short-run cost, design flexibility, reparability, established reliability, familiarity and fast design reaction time. But they are threatened for reasons of cost and reliability by both integrated circuits and hybrid circuits.

Factors affecting the decisions of whether or not to specify integrated circuits as cited in the Little report include:

• **Cost**—Factory cost of semiconductor integrated circuits is $1.09 per unit at a production rate of 65,000 units per month. This is production line output balanced around one bank of diffusion furnaces. Factory cost of a silicon planar transistor produced in a quantity of one million per month by a high-speed mechanized factory is 28 cents, the report says. Thus, the startling and compelling conclusion is that an entire semiconductor integrated circuit will cost less than the transistors alone in any discrete or hybrid circuit employing four or more active elements," the consulting firm states. At a production rate of one million units a month, semiconductor integrated circuit cost drops to 45 cents, making it cheaper than equivalent discrete transistors alone as long as more than one transistor is used per circuit.

But even the 65,000 units per month figure is excessive for anything other than a large computer system which uses great numbers of similar circuits. Hence, a more practical question, the report notes, is how costs would compare for many different circuit types in small quantity orders. The underlying factor here, in custom runs, is the cost of masks for making circuits. Little says these costs run about $5,000 per set (AVIATION WEEK & SPACE TECHNOLOGY has reported previously that semiconductor manufacturers each last year quoted mask costs to the customer ranging between $1,000 and $20,000). With an anticipated order of magnitude reduction in mask costs within the next three to five years and advances in circuit design and process scheduling

Little foresees semiconductor integrated circuits becoming cost competitive with in three to five years

Calculated factory cost for thin-film circuits at a production rate of one million units per month is between 30 cents and 56 cents depending on the size of the substrate Once discrete active components are added even if it is only a single active element, the cost of the thin-film hybrid exceeds that of the semiconductor integrated circuit in high volume production

Thin film mask costs are less than those of semiconductors This creates a situation as depicted in an accompanying chart (see p 87) of a family of equal cost curves for semiconductor integrated circuits and thin film hybrid circuits as a function of total quantity produced and mask costs for an increasing number of transistors per circuit Shorter runs favor thin-film hybrid circuits By examining the chart for a typical circuit such as a flip-flop (which employs two active elements) it can be seen that at an arbitrary semiconductor mask cost of $500 per set, a run of more than 3,100 circuits is necessary to justify economically a resort to semiconductor integrated circuits in preference to thin-film hybrids For fewer circuits (below equal cost lines on the graph) thin film hybrids are more economical Clearly reduction in mask costs is a key to the economic success of semiconductor integrated circuits

• **Price**—Forecast of equivalent circuit prices based on factors of cost current price developments, technological maturity, industry plant capacity, competition and production levels, is shown in an accompanying chart (see p 93) The price profile for semiconductor integrated circuits according to Little predictions will be repetitions of that for transistors, except that prices initially will drop more rapidly than did transistor prices in their decline since 1959 Military and high quality commercial digital units presently cost competitive with discrete circuits, will become more so in the next several years Analog circuits, on the other hand, will be higher priced because they are newer, more tolerance-sensitive and more customized, and they are desired in smaller quantities They will become price competitive within five years, according to Little

• **Size**—Microminiature discrete assemblies can realize packing densities of 100,000 parts per cubic foot, and thin-film hybrid circuits ultimately 10 million per cubic foot, while semiconductor circuits can go to 100 million parts per cubic foot

• **Reliability**—Little estimates three to four years will be required to establish the reliability of either thin film hybrids or semiconductor integrated circuits, even if a comprehensive reliability program not yet in the offing were to be started immediately Predicted order of magnitude improvement in reliability over discrete component assemblies is based on extended use of planar technology and deposited aluminum interconnections to replace lead soldering and welding

• **Other factors**—Additional factors weighing on the decision to use or disregard integrated circuits and hybrids include loss of design and maintenance flexibility offered by discrete component assemblies, slower reaction times the absence of adjustability and tuning and the substitution of emphasis on process and quality control since integrated circuits are process products

Investment and skills required to achieve three levels of R&D capability in integrated and hybrid circuits, as cited by the Little report, include

• **Small effort**—For either thin-films or semiconductor integrated circuits this would consist of nine professional engi

Plant Investment Estimates

Type of Circuit SCIC	TF	Monthly Production Rate	Over-all Yield (%)	Type of Operation Manual	Mechanized	Total Plant Investment ($ Millions)	
X		65 000	51	X		0 5	
X		1,000 000	51	X		3 8	
X		1,000 000	51		X	4.2	
X		85 000	75	X		1 1	
X		1,000 000	75		X	10 3	
						¼" x ¼"	½" x ½"
	X	75 000	72	X		0 5	0 9
	X	540 000	72		X	2 8	5 5
	X	1,000 000	72		X	4.1	10 0

TOTAL PLANT INVESTMENT required to produce semiconductor integrated circuits and thin-film passive element circuits according to calculations of Arthur D Little, Inc., is shown All estimates pre-suppose a double-shift operation In semiconductor integrated circuits, wafer operations are manual but preparation of die and headers is manual or mechanized, as indicated in the table

NASA Analysis

Arthur D Little Inc will conduct a market analysis to determine how and where microelectrnics best applies to National Aeronautics and Space Administration's needs under a NASA contract.

Analysis is expected to pinpoint where research and development efforts are required to advance the state of the art in microelectrnics.

neers a capital investment of $450,000 and in annual expenditure of $275,000. This facility could keep abreast of the state of the art in making design prototype and production items in support of engineering programs applying circuits made by others and perhaps turning out several thousand units a month.

• Medium effort—This facility would employ 22 professionals and require $1 million in capital investment and $690,000 in annual upkeep. It could provide for limited innovation and a capability for substantial application support including production prototypes and an in-house production capability of 30,000 circuits a month.

• Large effort—With a staff of 48 professionals this facility would require $2,150,000 capital investment and in annual upkeep of $1.4 million. It would yield a major competitive position and allow for invention and advancement of the state of the art in either thin films or semiconductor integrated circuits.

Estimates of the total capital investment for production equipment building and plant site to achieve varying levels for different circuit types are shown in table (see p. 95).

Thermionic Generator

Thermionic generator to be tested in a solar thermionic power system by Jet Propulsion Laboratory using 5-ft-dia. concentrator has delivered up to 80 w. of power during lab tests with efficiencies up to 7.4%. Generator consisting of five elements connected in series mounted on cubical cavity with one side open to receive solar energy was developed by Thermo Electron Engineering Corp., Waltham, Mass. Generator weighs 3.3 lb. Thermionic emitters will operate at temperature of 1,700C.

FILTER CENTER

► **Lear Siegler Ponders Semiconductor Move**—Lear Siegler, Inc., is considering entry into the semiconductor field either by acquiring an existing semiconductor company or by recruiting key personnel experienced in semiconductor technology. The company has made studies of several firms and has had discussions with engineers who might form the nucleus of a new semiconductor operation.

► **Thin Films From Electro-Chemical Reactions**—Texas Instruments is conducting research on thin films formed by electro-chemical reactions under Army Signal Corps contract. The company recently was granted an extension of another military contract from USAF's Aeronautical Systems Div., for research on organic materials suitable for avionic applications.

► **Electromagnetic Radiation Effects**—Study of the effects of high energy electromagnetic radiation on various semiconductor devices including NPN and PNP transistors, field effect transistors, and diodes, is contemplated by NASA's Marshall Space Flight Center. Proposals on the subject are due at Huntsville Mar. 1.

► **Boeing 727 Autopilot Undergoing Tests**—Early flight tests of the Sperry Phoenix SP 50 autopilot intended for use in Boeing's short to medium range 727 jet transport have been successful. In one maneuver, a dutch roll purposely induced with the yaw damper disengaged was damped out by subsequently engaging the yaw damper. The autopilot was operational for the first 727 flight but was not engaged because of insufficient opportunity for quality control of the installation itself. In a subsequent flight the autopilot was energized from taxi roll through flight and landing.

► **Laser Beams Penetrate Plasma**—Light beams from a ruby optical maser have penetrated the plasma which may surround a space vehicle re-entering the earth's atmosphere, engineers from Douglas Aircraft's Missile & Space Systems Div. report in the current issue of the Proceedings of the Institute of Electrical and Electronic Engineers. The plasmas were produced by shock waves on fixed models in a hypervelocity wind tunnel. Two types of re-entry situations were simulated—one of a vehicle orbiting the earth at 216,000 ft. altitude and velocity of 25,000 ft./sec., the other of a vehicle at 245,000 ft. altitude and velocity of 43,400 ft.

sec. Results closely correspond, within experimental accuracy, to expectation that light of this wavelength (6943 A) will not be attenuated significantly by plasmas.

▶ **Signed on the Dotted Line**—Major military contract awards that have recently been announced by various avionics manufacturers include the following:

• **Columbia University**, New York City, has received $1.5 million contract for research on radar and defense problems from the USAF Office of Scientific Research.

• **Aeronutronic Division**, Ford Motor Co., Newport Beach, Calif., will conduct experimental investigation of infrared radiation from hot water vapor and carbon dioxide, both major rocket exhaust products, and its transmission through the atmosphere under $120,000 contract awarded by Defense Dept.'s Advanced Research Projects Agency. Study presumably is connected with the Midas early warning satellite program.

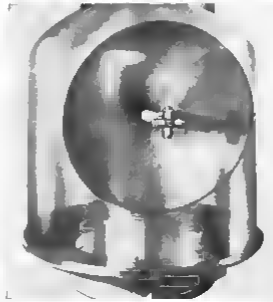
• **Hamilton Standard Division**, United Aircraft Corp., Windsor Locks, Conn., will investigate use of electron beams for welding in space under $340,000 contract from Aeronautical Systems Division.

Inverse-Pinch Plasma Generator Developed

Inverse pinch plasma generator, Model "Q", capable of expanding plasmas at rates up to 10 million cm./sec. into magnetic fields as strong as 2,000 gauss, has been developed by Aracon Laboratories, Concord, Mass. Research program is funded by Advanced Research Projects Agency as part of its Project Defender ICBM-defense program. Generator can inject gases with a mass of 0.1 to several hundred micrograms, company says.

NEW AVIONIC PRODUCTS

• **Broadband circularly polarized antennas**, for operation over frequency range of 1.0 to 2.6 gc (kmc.), have 24-in. dia. parabolic reflectors with crossed dipole feed producing gain of 14.20 db. Model



A610-04L has 115 v., 60 cps drive motor while similar Model A610-05L has servo-controlled drive motor. Antennas are available with glass fiber radome. Manufacturer: General Electronic Laboratories, Inc., 18 Ames St., Cambridge, Mass.

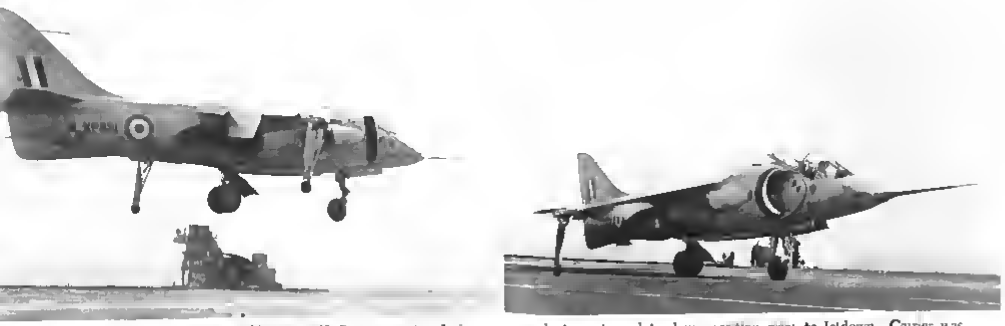
• **RF spectrum analyzer**, Type 1 BS, scans entire tuning range of a receiver and analyzes signal frequency characteristics which are recorded on strip chart. Analyzer can operate from audio rectified intermediate-frequency into matic volume control or discriminator voltage. Instrument weighs 60 lb., operates from 50-60 cps 110/200 v. power. Manufacturer: Rohde & Schwarz, 111 Lexington Ave., Passaic, N.J.

• **Micro-current sensor**, capable of measuring currents as small as 0.1 millimicroampere and charges as small as 0.1 millimicrocoulomb, operates up to temperatures of 80C. The Model RW-600 sensor uses vibrating reed in a magnetic field and can be connected to an auxiliary readout or counting device. Accuracy at constant temperature is quoted at 1.5%. Manufacturer: Warnecke Electron Tubes Inc., 175 West Oakton St., Des Plaines, Ill.

• **Tunnel diode amplifiers**, in variety of types and frequency ranges provide low-noise operation. Model NC-6150B has a 500 mc. bandpass at the 1 db. point centered at 6,150 mc., with noise figure of 4.2 db. and a nominal gain of 17 db. Device uses gallium antimonide tunnel diode, weighs less than 6 lb. including solid-state power supply. Model NC-0902 has bandpass of 25 mc. centered at 956 mc. with gain of 20 db. When operated into second stage having gain of 14 db., system noise figure is 3.9 db. Model NC-2101B provides noise figure of less than 4 db. for a second stage of up to 12 db., with a 30-mc. bandwidth centered at 2,115 mc. Total weight of amplifier is 4 lb. including power supply. Manufacturer: Micro State Electronics Corp., 152 Floral Ave., Murray Hill, N.J.

Hawker P.1127 VTOL strike fighter hovers off the deck of the British aircraft carrier Ark Royal prior to making first VTOL jet landing as part of recent Royal Navy sea trials. Aircraft was flown from Dunsfold, England, test base to the Ark Royal, then under way in the English Channel (AW Feb. 18, p. 41)

P.1127 Makes First Jet VTOL Carrier Landing



Nozzles of the Bristol Siddeley BS.53 Pegasus vectored thrust powerplant are turned to down position prior to letdown. Carrier was steaming at 15 kt. at time of landing. Right, aircraft is taxied prior to being prepared for elevator lowering to hangar deck (below)

CONTRACTS

AFOSR Grants

Air Force Office of Scientific Research recently awarded the following grants and contracts to universities and research firms in U.S. and Europe.

GRANTS

Rensselaer Polytechnic Institute, Troy, N.Y.—$85,550 for investigation of fundamental atom-chemistry-surface catalyzed excitation.

Purdue Research Foundation, Lafayette, Ind.—$21,536 for nitrogen trace analysis by combination chain reactions; $20,678 for continuous measurement of solid propellant burning rate.

University of British Columbia, Vancouver, Canada—$10,150 for investigation of atom recombination.

University of Western Ontario, Ontario, Canada—$44,704 for study of photochemical production of strained rings.

Princeton University, Princeton, N.J.—$25,924 for study of kinetics and mechanism of electrolytic film formation reactions; $65,933 for study of equilibria and mechanisms in ionic polymerization.

University of Massachusetts, Amherst, Mass.—$42,720 for study of dynamic birefringence of polymeric solids.

Polytechnic Institute of Brooklyn, Brooklyn, N.Y.—$30,000 for study of dynamics and vibrations of plates and shells.

Pennsylvania State University, University Park, Pa.—$31,090 for study of effect of environmental conditions on the mechanism of failure.

Case Institute of Technology, Cleveland, Ohio—$21,971 for study of effect of body forces on the motion and heat transfer of confined fluids.

University of Virginia, Charlottesville, Va.—$50,000 for study of electronic suspension system for the measurement of aerodynamic characteristics.

University of California, Berkeley, Calif.—$4,000,064 for research in physical electronics and electronic systems; $50,240 for study of algebraic geometry; $152,287 for computational research in astrophysics.

Massachusetts Institute of Technology, Cambridge, Mass.—$35,242 for investigation of interactions among burning fuel droplets.

Ohio State University, $50,024 for research in nonlinear R.F. field plasma.

University of Illinois, Urbana, Ill.—$180,808 for investigation of charged colloidal sized particles for propulsion.

University of Arizona, Tucson, Ariz.—$42,118 for study of the design organization and performance of hybrid computer systems; $24,396 for study of impact of technological change on executive and professional careers in military and civilian organizations.

University of Pennsylvania, Philadelphia, Pa.—$10,640 to study the deformation system design for information processing field.

University of Kansas, Lawrence, Kans.—$30,018 to study the sensory basis of the orientation to linearly polarized light.

University of California, Los Angeles, Calif.—$80,394 for investigation of energetic muscle activity in relation to molecular physiology of the contraction process.

Carnegie Institute of Technology, Pittsburgh, Pa.—$8,979 for study of variations in preceptual responses as a function of required ones.

Harvard University, Washington, D.C.—$7,938 for investigation of youth motivation.

Colorado State University, Ft. Collins, Colo.—$14,758 for investigation of approximations using orthogonal functions.

Brown University, Providence, R.I.—$64,460 for study of feasibility of phonon dilution in liquid helium.

Brandeis University, Waltham, Mass.—$45,421 for study of classical and quantum many body theory.

Johns Hopkins University, Baltimore, Md.—$11,571 for investigation of far infrared spectroscopy; $37,248 for study of spectra of doubly and triply ionized rare earths.

New York University, New York, N.Y.—

Westland SRN-2 Tested on Ice

Westland SRN 2 Hovercraft has been operating in ice packs recently near the Isle of Wight as part of the vehicle's winter testing program. Vehicle has operated successfully over pack ice up to 9 in. thick and floes more than 6-ft. long.

$39,[illegible] for atomic hydrogen recombination studies.

University of Southern California, Los Angeles, Calif.—$51,[illegible] for study of plasma and magnetohydrodynamics and for research in shockwave ionization phenomena, optical coherence and laser.

Texas A. & M. College, Station, Tex.—$19,024 for investigation of nuclear magnetic resonance study of liquids and liquid mixtures.

McMaster University, Ontario, Canada—$[illegible],839 for study of nuclear stability and nuclear [illegible] by means of atomic mass determinations.

Catholic University, Washington, D. C.—$119,[illegible] for basic research in [illegible] plasmas.

Brigham Young University, Provo, Utah—$2[illegible],868 for investigation of diffusion in metals at ultra high pressures.

Clemson College, Clemson, S. C.—$81,840 for study of [illegible] and galvanomagnetic properties of single crystal metals.

City College of the City University of New York, New York, N. Y.—$1[illegible] for investigation of the infrared absorption in strained silicon.

University of North Dakota, Grand Forks, N. D.—$55,[illegible] for investigation of residual stresses in silicon resulting from strain distortion around impurities.

Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y.—$41,[illegible] for study of non-equilibrium flows; $44,[illegible]24 for investigation of boundary layers in high temperature flows; $39,808 for investigation of molecular interactions at high temperature.

North American Aviation, Inc., Downey, Calif.—$84,153 for research on stability and transition of the laminar boundary layer.

Southwest Research Institute, San Antonio, Tex.—$[illegible] for research in the field of high temperature technology.

Armour Research Foundation, Chicago, Ill.—$18,612 for determination of the structures of [illegible]; $38,[illegible] for investigation of phase [illegible] in [illegible] isothermal field.

Aeronutronic Research Laboratories, Princeton, N. J.—$49,[illegible] for study of oxidation of metals by partially dissociated oxygen.

Ford Motor Co., Newport Beach, Calif.—$45,5[illegible] for study of reflection and scattering of sound by flames.

Litton Systems, Inc., Beverly Hills, Calif.—$194,845 for study of electromagnetic plasma acceleration.

General Dynamics Corp., Rochester, N. Y.—$1[illegible],709 for study of communication and information theory aspects of the nervous system.

Geofix, Inc., Albuquerque, N. M.—$[illegible]754 for general adaptive motor learning program for a digital computer.

Martin Marietta Corp., Baltimore, Md.—$41,9[illegible] for research on problems of control.

I.B.M., Yorktown Heights, N. Y.—$178,135 for study of vapor solid growth of semiconducting crystals.

Instituto Nacional de Tecnica Aeronautica, Madrid, Spain—$13,000 for study of premixed and diffusion spherico-symmetrical flames; $19,[illegible]80 for study of diffusion flames and supersonic combustion.

University of Oxford, Oxford, England—$9,200 for study of reactions of atoms and radicals with various molecules; $13,600 for study of waves in anisotropic media.

University of Louvain, Louvain, Belgium—$13,500 for study of reaction kinetics in flames.

Max Planck Institut fuer Zellchemie, Muenchen, Germany—$9,880 for study of biosynthesis mechanisms involved with formation of terpenes and also terpene derivatives.

Institute of Laryngology & Otology, London, England—$5,000 for Trinidad expedition 1963; $12,740 for study of echo location in bats.

Hopital Henri Rousselle, Paris, France—$9,000 for study of relation of visceral afferents on activity of brain stem reticular formation.

University of Brussels, Brussels, Belgium—$9,300 for study of neurophysiological correlates of sensory perception.

University of Cambridge, Cambridge, England—$14,220 for investigation of effects of cerebral lesions on respiration and timing.

University of Paris, Orsay, France—$30,[illegible] for theoretical studies of elementary particles interaction.

University of Bern, Bern, Switzerland—$21,[illegible] for study of thermal and radiation effects in space.

Uppsala University, Uppsala, Sweden—$42,800 for band structure by ultrasonic susceptibility and galvanomagnetic investigation.

University of Maryland, College Park, Md.—$95,715 for investigation on phenomena surrounding high-speed flow; $26,6[illegible] for study of boundary layer instability and transition.

Princeton University, Princeton, N. J.—$[illegible] for investigation of high speed gas dynamics; $81,411 for study of propellant ignition and igniter characteristics; $17[illegible] for study of combustion processes in liquid propellant rocket motors; $20,942 for theoretical research on stellar evolution.

University of Minnesota, Minneapolis, Minn.—$[illegible] for theoretical and experimental investigations of mass transfer cooling.

Stanford University, Stanford, Calif.—$43,534 for studies in hypersonic flow theory; $35,232 for study of basic structures and stability of turbulent shear flows; $93,025 for investigations of aircraft missile structures operating at high temperatures; $29,253 for investigation of optimum control.

Cornell University, Ithaca, N. Y.—$111,000 for investigation of chemical reactions in shock tubes; $42,3[illegible] for investigation of organic electro oxidations; $44,[illegible]01 for investigation of mechanism of the Diels-Alder Reaction.

Pennsylvania State University, University Park, Pa.—$17,471 for study of effects of triaxial stresses on mechanical properties of metals under high pressure; $1[illegible],132 for investigation of transient thermal stresses in solids; $45,151 for study of the physical properties of substances by means of acoustical measurements; $1[illegible],200 for investigation of physical properties of biologically substituted fluids.

Massachusetts Institute of Technology, Cambridge, Mass.—$34,788 for research into gas-solid surface interaction phenomena; $34,188 for study of unsteady gas dynamic problems related to flight vehicles; $15,000 for investigation of Bolivian air shower joint experiment; $3[illegible],028 for investigation of neurological systems and underlying physiological mechanisms; $15,998 for investigation of non linear systems.

National Academy of Sciences, Washington, D. C.—$1[illegible],080 for AFOSR postdoctoral research fellowship program.

Brown University, Providence, R. I.—$37,129 for experimental and theoretical research in magneto gas dynamics.

University of Missouri, Columbia, Mo.—$2[illegible],174 for investigation of energy exchange between solids and gases.

Northwestern University, Evanston, Ill.—$33,138 for investigation of dynamic behavior of solids; $27,200 for topological synthesis of N-port networks; $27,372 for investigation of heterogeneous catalysis in liquid systems.

California Institute of Technology, Pasadena, Calif.—$81,354 for general investigation of growth of plasma layers in plasma accelerators.

University of California, Berkeley, Calif.—$77,150 for study of development and stabilization of dislocations; $81,090 for research in microwave electronics; $30,000 for investigations of atomic physics and many particle interactions.

University of Utah, Salt Lake City, Utah—$20,300 for exploratory research on communication abilities and creative abilities.

Case Institute of Technology, Cleveland, Ohio—$2[illegible],900 for research on artificial intelligence.

Rockford Research Institute, Inc., Cambridge, Mass.—$4,131 to study the statistical detection theory in communication systems.

Columbia University, New York, N. Y.—$2[illegible],766 for study of application of optical masers to problems in chemical physics.

University of Virginia, Charlottesville, Va.—$91,818 for determination of the degree of ionization of gas plasma as a function of X-ray energy.

Dartmouth College, Hanover, N. H.—$40,[illegible]07 for investigation of the PVT relations in solid He[3] and solid He[4] and of flow measurements with super-fluid helium; $16,100 for study of functional analysis and probability theory.

University of Vermont, Burlington, Vt.—$104,531 for investigation of non-linear sonic phenomena.

University of Rochester, Rochester, N. Y.—$73,560 for research on fundamentals of geometric optics.

University of Chicago, Chicago, Ill.—$310,197 for experimental investigation of the electronic properties of solids.

University of Southern California, Los Angeles, Calif.—$91,707 for the micro analysis of solid state electronic materials; $25,040 for investigation of the invariants in algebraic topology; $50,34[illegible] for models for asymmetric induction in polymerization.

Johns Hopkins University, Baltimore, Md.—$12,600 for study of gastrointestinal absorption of various compounds.

REPUBLIC F-105D MACH 2 STRIKE FIGHTER is capable of carrying 16 750-lb. bombs externally after modifications currently under way. Five are carried under each wing and six under the fuselage. Modifications include wing racks and center line fuselage rack. Aircraft also carries 1,000 lb. of Vulcan cannon ammunition for a total conventional weapons payload of 13,000 lb. Aircraft based in Germany currently are being flown to the United States for major modifications

F-105D's Limited-War Capability Boosted

By Cecil Brownlow

Bitburg Air Base, Germany—Aircraft of the U. S. Air Force's two Republic F-105D fighter-bomber wings in Germany are being funneled through an intensive $14-million modification and conversion program designed to substantially boost their conventional warfare capability as well as introduce a number of modifications devised after the aircraft entered service.

For the early F-105D-10 models used here by the 36th Tactical Fighter Wing, approximately 385 technical order changes have been issued by USAF for each aircraft to transform it to a –25RE configuration. This is the latest version now rolling off Republic's Farmingdale, N. Y., production line. A progressively smaller number of changes are needed for the –15 and –20 models, some of which are in service with the 49th Tactical Fighter Wing at near by Spangdehlem Air Base (AW May 22, 1961, p. 74).

Similar modification program is under way for U. S.-based F-105 units, while a new wing presently being activated in Okinawa is receiving the –25RE version directly from the production line.

Overall, an estimated 20% of the dollar cost of the program is going into basic design improvements and fixes. The remaining 80% of the cost for Operation Look Alike' is designed to give the aircraft an improved potential for fighting conventional wars. The F-105D originally was designed primarily as a nuclear weapons platform.

Latter move is being made in line with President Kennedy's call to the armed forces to increase their capabilities in this area to free the U. S. from the necessity of having to immediately resort to the use of nuclear weapons in the event of a Soviet conventional arms thrust into West Europe. Order also was designed to give the country a greater capacity for meeting peripheral, Communist-inspired 'brush fire' wars in other areas of the world.

Majority of the modifications are concerned with the airframe and its direct components. Waterproofing of the fuselage to prevent seepage from damaging the aircraft's avionic systems is the only major work currently being done to benefit these systems.

However, follow-on modification program under consideration would be directed primarily towards the avionic units, with greater reliability and a longer mean-time-between-failures (MTBF) as its goals. Aircraft emerging from this project would be identified as the –51 version.

Present modifications include installation of external racks under each wing and beneath the fuselage center section to provide stations for 16 bombs weighing up to 750 lb. each. This will boost the F-105's conventional weapons payload to a total of 13,000 lb. Installation of the wing racks is unpopular with at least some F-105 pilots who foresee a possible stability problem if the aircraft load becomes asymetrical. They would prefer, instead, one long rack positioned along the fuselage center line.

Eight of the technical orders pertain directly to a fuel line and electrical wiring chafing problem that has been encountered both at Bitburg and Spangdehlem. Although no lines have actually been cut through a number have become worn and were changed as a safety precaution. As a result, the chafing, described by one maintenance officer as "our major problem," contributed to a lowering of the average number of F-105Ds in commission throughout 1962.

(Continued on p. 107)

LACK OF ENCLOSED FACILITIES at West German F-105 bases forces most aircraft to sit out in all weather conditions at present. Gray water sealant paint is being applied to stop seepage which has been affecting instruments and avionics packages. Car port type shelters also are being introduced in an effort to give the aircraft some protection from the elements

Other fixes include a wing modification for better performance, changes in the refueling probe and a general strengthening of the fuselage to forestall a possible 3,000-hr. fatigue problem encountered during Air Force structural tests in the United States.

In the waterproofing modification, the aircraft will be coated with a battleship gray sealant paint. Water seepage into avionic units has been a continuing problem for the two Wings. Majority of their aircraft must remain positioned along outside ramps in all weather conditions, exposed to a heavy rainfall in the spring, summer and fall that changes to snow in the winter.

A canopy seal also is being provided in the modification program that can be used when the aircraft is sitting on the ground in inclement weather to keep water out of the cockpit and cockpit instrumentation.

Aircraft Shelters

In another move to combat the problem, Bitburg plans to build a number of carport type structures to house individual aircraft. Spangdahlem now has in place three surplus open-end prefabricated shelters designed originally for the Convair B-58 supersonic bomber. Each can accommodate two F-105s, and 49th Wing Commander Col. Thomas D. DeJarnette hopes to receive sufficient additional units during the year to provide most of his aircraft with shelter from the weather conditions of the surrounding Eifel Mountain area.

Shelters for aircraft on alert at the end of the runway also are needed—each wing has 12 planes on this status at all times.

The modifications themselves are being completed in two phases. Technical changes requiring less than 10 hr. to complete generally were conducted at Bitburg and Spangdahlem by approximately 300 Republic Aviation technicians flown to Europe for this purpose. A majority of the on-base modifications were concerned with air safety fixes.

On a phased basis designed to leave each wing's operational capability intact, the aircraft are now being flown to the Mobile, Ala., Air Materiel Area for the major modification work by USAF personnel. The 36th and 49th presently have 20 aircraft each at Mobile and expect the return flights to begin sometime in March. First modification flight to Mobile from Bitburg was in October.

Total projected time for all aircraft to go through the program is between eight and nine months although some of the initial planes may emerge without all the modifications needed to conform to the -25RE specifications. These will be installed in the field at a later date.

Once the program is in full swing, scheduled flow time for an aircraft through Mobile will be one month. Work on U.S.-based aircraft will not interfere with Mobile's work on F-105Ds of the 36th and 49th Wings since the former are being modified by Republic at Farmingdale.

Mirage 3V Mission

Paris—Dassault Mirage 3V supersonic VTOL fighter will be used primarily as a tactical nuclear-armed strike fighter under France's evolving plan for an independent atomic weapons capability. Present programing reportedly calls for an order of approximately 150.

In a low level Mach .92 attack mode the Mirage 3V has a design combat radius of 250 naut. mi. with a 2,000-lb. nuclear payload. Using a more economical high-level approach coupled with a final low-level penetration attack combat radius could be stretched to 400 naut. mi. with a 1,200-lb. payload.

Flight Preparations

The flight to Mobile itself causes some disruption in schedules here and places an added strain on the understaffed maintenance units. It requires an average of 4½ days to prepare an aircraft for the flight, including the installation of extra tankage and readiness test flights. Planes are then flown back in flights of four, although six are normally prepared and fueled to compensate for any last-minute aborts.

The 4,400-mi. non-stop flight to Mobile requires approximately 10½ hr., with three refuelings.

The on-base modification work at Bitburg and Spangdahlem began in late September with kits previously purchased by the government and shipped to the two sites. Initially, the Republic technicians required more than seven full working days on each aircraft. During the latter stages of the program, this figure was trimmed to about four days per aircraft.

Over-all at Bitburg maintenance officers says, "it turned out to be a real good program. When they started, I was willing to bet they wouldn't come near the Nov. 30 deadline but they beat this by one week."

Air Force personnel aided in the program by stripping down the aircraft before modification work was begun and by conducting acceptance flight tests after it was completed.

The 36th and the 49th are hampered by a shortage of qualified personnel to

SURPLUS PRE-FABRICATED ENCLOSURES originally designed to house B-58 bombers are being used by the 49th Tactical Fighter Wing to protect its F-105Ds from weather. Each of the three enclosures on hand at present can shelter two F-105s.

perform day-by-day maintenance work on such a complex weapon system as the F-105D. Problem is particularly acute since the aircraft are left out in the weather for long periods.

At the moment, the two wings have about 85% of their authorized maintenance personnel. Spangdahlem's F-105 mechanic roster has dropped to as low as 62% of the authorized strength during the past few months.

Experience Factor

Another factor is that less than one per cent of the maintenance force of the two wings had previous F-105 experience before reporting to Germany. The wings have on-base training detachments whose work is supplemented by trainee instruction by Republic field representatives, which partially offsets the lack of experience.

Major concern is with the avionic systems, although reliability average has been edging upwards as maintenance and operational experience has been gained, despite the continuing problem of water seepage into the components. The two wings are operating with approximately half of their authorized test bench equipment in operation, primarily because of lack of space.

System with the largest average number of write-ups is North American Aviation's NASARR –31MC all-weather fire control unit, with about 800 work orders written per month at Spangdahlem. The majority of these, however, can be corrected by cockpit adjustments.

Doppler navigation system made by the Laboratory For Electronics (LFE) receives the next largest number of reports. Approximately 600 work orders per month are written at Spangdahlem, according to Col. DeJarnette.

Mean-time-between-failure for the complete avionics package has been on the increase, however. A Republic survey of a recent five-month period during which the 49th flew 7,038 hr. in 4,164 sorties shows the following computed mean-time-between-failure in the air for the F-105's major avionic systems:

- **Radar** (North American)—10.1 hr.
- **Instruments**—12.3 hr.
- **Communications**—14.6 hr.
- **Doppler** (LFE)—17.8 hr.
- **Autopilot** (General Electric)—23.2 hr.
- **Toss bomb computer** (General Electric)—34.0 hr.
- **Gun sight** (General Electric)—57.7 hr.

Over the same period, success rate for scheduled sorties at Bitburg was 92%, or 286 aborts versus 3,553 sorties actually flown. Launch success rate for avionic systems alone during the period was 93% with 288 electronic aborts as opposed to 4,164 sorties flown.

The Republic study, backed by the experience of maintenance personnel at both bases, shows that approximately one half of the aircraft returning with avionic write-ups require only minor maintenance and can be available for flight within five hours.

Engine Problem

Another, and as yet unexplained, problem has been the tendency in some instances for the aircraft's 26,500-lb.-thrust Pratt & Whitney J75-P19W powerplant to surge, resulting in an engine flameout.

On occasion, pilots have been unable to obtain a re-light and an aircraft has been lost.

Pratt & Whitney and Air Force officials say that, thus far, the problem is "unexplainable" and that investigations of the incidents have not yet led to any determination of where the problem lies—whether it is in the engine itself, its fuel system or in some other accessory unit.

Direct labor requirements for the aircraft as a whole also have been on the decline. Col. Robert L. Delashaw, 36th

Wing commander says that approxi-mately 45 maintenance hours now are required for each flight hour. "In my view, [this is] not a very bad situation in this particular stage with the air-craft," he said. The 36th, first Europe-based wing to fly the F-105, re-ceived its first aircraft in May 1961. Airplanes for the 49th began arriving five months later.

Overall, Delashaw says the 36th is "quite happy" with the operational ca-pability of the aircraft; the unit's fully op-erational all weather strike fighter now in Western Europe.

While the later-model NASARR unit on the Lockheed F-104G has a ten-dency to lose scope clutter in its air-to-air mode, primarily because of the smaller size of the radar dish and the long metal nose through which it has to probe, Delashaw says he has detected no such problem in the F-105's system. The aircraft is primarily a strike fighter and the air-to-air intercept mode is used sparingly.

Main concern of both Delashaw and DeJarnette is to build up the number of hours flown. DeJarnette estimates that a pilot requires 20 hr. of flying time per month to maintain his combat-ready status.

To attain this, the 49th would need to amass a total of 2,100 hr. per month. At present, only 1,600 hr. maximum is available with the present maintenance capability of the wing. Current average flight time for a 49th pilot is about 12.5 hr.

Aside from maintenance, there are a number of other factors which tend to lower average flight time. One, again, is the weather encountered here, where the problem often is not so much in the airborne phase but in taxiing and take-off. Runways and taxiways tend to un-dulate. They also slope toward the sides, and the difficulty in winter is to keep the aircraft from sliding off the icy paved surfaces.

Col. Delashaw estimates that year-round well over 65% of the wing's fly-ing time is under instrument conditions and that practically all landings are made via ground-controlled approach (GCA).

Also, because of the wings' opera-tional commitments, no aircraft is ap-proved for takeoff on a training mission in the area unless all systems are operat-ing and ready for use. Despite this, the two wings together accumulated a total of 33,000 flying hours in approximately 20,000 sorties during the first 16 months of F-105 operations in Europe.

Utilization rate per month per air-craft during the first three quarters of 1962 for the two wings ranged from a low of 15.1 hr. to a high of 28.2 hr., according to the Republic study. Aver-age was about 19 hr. per month calcu-lated on the basis of an average 69.1 planes in each wing.

With all the handicaps between 92% and 95% of the pilots in each wing are qualified as combat ready—a difficult status to attain. Requirements stipulate that, before qualifying, a pilot must meet unit training standard re-quirements on 7 of the 11 F-105 weapon delivery modes. Present requirements of the wings for circular error accuracy of weapon impact exceed Air Force design specifications for the F-105 by almost 12% in some modes, according to Re-public.

Additional Bell OH-4As Under Construction

Four additional Bell OH-4A helicopters are under construction at company's Fort Worth plant. Helicopter is a competitor in the Army's light observation helicopter (LOH) com-petition. First of five prototypes flew Dec. 8 (AW Dec. 17, p. 30). Aircraft since has made 10 test flights and currently is undergoing tie-down ground runs preparatory to starting 100 hr. ground run for Federal Aviation Agency. OH-4A is powered by a 250-shp Allison T63-A-5 engine and can carry four persons.

NEW LONDON, Conn., (left) and Groton (right) photographed from 1,200 ft. with a Fairchild Defense Products' F-415 rotating prism panoramic camera in forward oblique mounting. Identifiable objects: Gold Star Memorial Bridge, New London submarine base, (right river bank, left of center fold); Electric Boat Div. yards, Groton (bottom, right river bank); U. S. Coast Guard training barque "Eagle" opposite Coast Guard Academy (white hull above intersection of bridge and left bank).

Rotating Prism Panoramic Camera Adds New Dimension to Photo-Recon Technique

By Ward Wright

New York—Forward oblique aircraft mounting of a high-speed, rotating prism panoramic camera is yielding 75% more coverage than a conventional frame camera in the same installation and could increase the flexibility of reconnaissance missions.

Camera, built by Fairchild Defense Products of Fairchild Camera and Instrument Corp., is an earlier version of company's F-415A rotating prism panoramic camera designed for vertical installation.

Vertically mounted and at maximum cycling rate the F-415A can make a continuous sequence of 180 deg. horizon-to-horizon, high resolution photographs at altitudes as low as 275 ft. and ground speeds of 600 kt. At 480 kt. photographs have been taken as low as 120 ft.

At all cycling rates F-415A capability provides for 60% overlap between individual exposures to ensure that the area is photographed at least twice for possible use in stereoscopic interpretation.

Panoramic camera concept is not new, having been used for years by group photographers and in slower aircraft at higher altitudes. Only recently has the rotating prism been applied to low level, high speed aerial photo reconnaissance. This concept is the only way to obtain a 180 deg. continuous exposure, compensated for image motion throughout the entire format, with high-speed low flying aircraft.

By making a continuous horizon to horizon photographic strip, the rotating prism panoramic camera eliminates some of the print matching problems associated with the more common trimetrogon or other multiple camera arrays. Trimetrogon station cameras are three separate frame cameras—one vertical and two mounted in the side oblique position—used to obtain horizon to horizon coverage.

Both trimetrogon and rotating prism photography require fore and aft matching of photos along the direction of flight. The rotating prism technique eliminates the need to match the two oblique frames with the center frame—a complicated step in trimetrogon photography.

The basic design phase for the camera began in October 1961, and it was delivered to Tactical Air Command last March. The camera became operational last fall, installed in some McDonnell F-101 aircraft. F-101s were used for reconnaissance during last fall's Cuban crisis.

Basically, the F-415A employs a "double dove" prism—two 5 in. triangular prisms joined along the surface, or plane—mounted so that it can rotate along the same line as the longitudinal axis of the aircraft. Joined prism forms a rectangular solid.

Prism begins its scan when the plane formed by the joined surfaces begins to rotate out of the horizontal position because light is deflected from the camera lens. As plane continues to rotate, light from horizon on the starboard side of the aircraft is deflected into the lens barrel. Simultaneously the film strip is started in motion. The prism continues its scan toward the port horizon and

LOCKHEED F-104 aircraft in West German installation. Transparent grid, compensated for markings photographed from 150 ft. at 480 kt. with Fairchild Defense Products' F-415A rotating prism panoramic camera in a vertical perspective and aircraft movement during prism's scan from horizon to horizon, is laid over print to allow quick measurement of area.

"paints" the image on the moving film strip

When the plane is again horizontal light can no longer enter the camera and film is stopped until the prism can again pick up the starboard horizon

During this cycle, the lens barrel, which is mounted on pivots, oscillates toward the rear of the aircraft to compensate for the apparent rearward movement of the ground image. This prevents the image from "smearing" or blurring during the exposure. The process is similar to the eye's ability to track a stationary object from a moving vehicle without turning the head. If the eye did not track, the image would blur. Rate of oscillation is controlled by the Image Motion Compensating mechanism.

When the cycle is complete, the lens barrel returns to the forward position ready to move to the rear again when the prism picks up the new horizon. At maximum cycling rate the prism rotates at three times per second. The lens barrel oscillates and film is started and stopped six times per second.

Airborne Computer

Image motion compensating rate is controlled by a small airborne computer, but can be programmed manually if ground speed and altitude are known.

Two points directly opposite each other on the earth's surface will not be opposite each other on the print because of the movement of the aircraft. Fairchild Defense uses a transparent coordinate grid overlay which compensates for the difference.

When the grid is laid over a print, accurate measurements can be scaled directly in ground coordinates.

Camera uses standard aerial reconnaissance film, has a focal length of 3 in., shutter speed from 1/100 to 1/5000 sec., and lens opening of f/4.5. Resolution is 38 lines per mm.

In the forward oblique mounting Fairchild Defense engineers installed a modified F-415 camera depressed 20 deg. from the horizontal in the nose of a chartered twin-engine Beech AT-11. Image motion compensation was not required since relative ground motion is less in the oblique position than in the vertical installation.

Greater coverage achieved by rotating prism panorama camera over conventional frame camera in forward oblique mounting could add an extra dimension to reconnaissance missions, Fairchild Defense feels.

In terms of mission flexibility, the aircraft need only approach the target from one side, take photographs, and return without having to fly past the target or directly at it.

Air Force is following the development program closely, Fairchild Defense says.

IBM

Systems and Scientific Programmers & Analysts

Explore excellent career assignments available with IBM's Federal Systems Division. Total systems development offers you unique opportunities to grow with the programming profession . . . to participate in the development of new techniques and programming applications. Immediate assignments are open with our advanced systems staffs in:

Programming analysis
Simulation programming
Real time operation programming

These include challenging tasks in:

Data Reduction
Decision Programming
Information Retrieval
Logistics Simulation
Message Switching
Numerical Analysis
Sound Recognition
Orbital Prediction
Problem-Oriented Language Processors

These are opportunities for personal and professional growth. In addition to educational and benefit programs, salaries are commensurate with ability and merit. Relocation expenses are paid. Locations are in Washington, D. C., Midwest, and Far West.

Assignments are available at intermediate and senior levels. Qualifications include experience in programming large-scale computer systems.

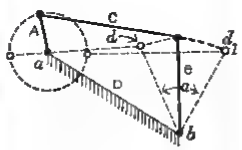
Write today, outlining your background, to

James H. Burg, Dept. 524B4
IBM Federal Systems Division
Bethesda 14, Maryland

An Equal Opportunity Employer

---

an opportunity



to use your

mechanical

ingenuity

If you enjoy the challenge of complex mechanical problems, you'll be interested in FMA.

FMA is one of the nation's leading producers of advanced electro-mechanical-optical systems for the fast-growing field of information technology. In exploiting the information storage potential inherent in the photographic emulsion, we have designed and developed sophisticated film transports, viewers, optical systems, and display devices. Mechanical engineering plays an important role in the development of this equipment, and mechanical engineers are often project leaders.

FMA can offer you the opportunities inherent in an expanding, successful company. Why not discuss this with us? Because of our continuing requirements, your resumé will always receive prompt and confidential attention.

Write to: Mr. C. J. Blades
FMA, Inc. 142 Nevada Street
El Segundo, California

FMA

AN EQUAL OPPORTUNITY EMPLOYER

When you think of inFORMAtion think of FMA

FREE TRIP IEEE (IRE) SHOW
NEW YORK CITY MARCH 25-28th

Electronic Scientists and Engineers you can have an all expense paid trip and weekend selected interview with national aircraft companies if you qualify. Requirements: BS, MS, or PhD and one year experience. Opportunities available in: Research — Design — Development — Sales — Marketing — Applications. Air Mail Resume in Complete Confidence — No Obligation.

Write or Call Collect Dept. A for Full Details
Boston (617) 444-7113

Alan Glou—Technical/Scientific
Sid Hooper—Sales/Marketing

PERSPECTIVE
A PROFESSIONAL PLACEMENT ORGANIZATION
TEN KEARNEY ROAD, NEEDHAM, MASS.
Highland Av. Exit 19W Off Rte 128—Barr Bldg.

SEARCHLIGHT

DOUGLAS DC-3

- **Completely rebuilt & modernized.**
- **18-place Deluxe Interior.**
- **Warranty on airframe & engines.**

Priced below cost of job.

L. V. Emery
Executive Aircraft Service, Inc.
Redbird Airport
Dallas 32, Texas
Phone. FEderal 1-6558

FOR SALE, LEASE or LEASE-PURCHASE
1 Convair 340
1 Convair 440—with large forward cargo door for combination operation
2 DC 4B's 1 DC 6A/B
Spare Parts and engines available.
FRANK LYNOTT, Executive Vice President
ALASKA AIRLINES Inc.
Seattle, Washington Cable: ALASKAIR

CONVAIR 340/440

Priced to Sell

- **Immediate Delivery.**
- **Airline Interior & radio.**
- **Will equip for "Executive" Use.**

L. V. Emery
Executive Aircraft Service, Inc.
Redbird Airport
Dallas 32, Texas
Phone: FEderal 1-6558

POSITION VACANT

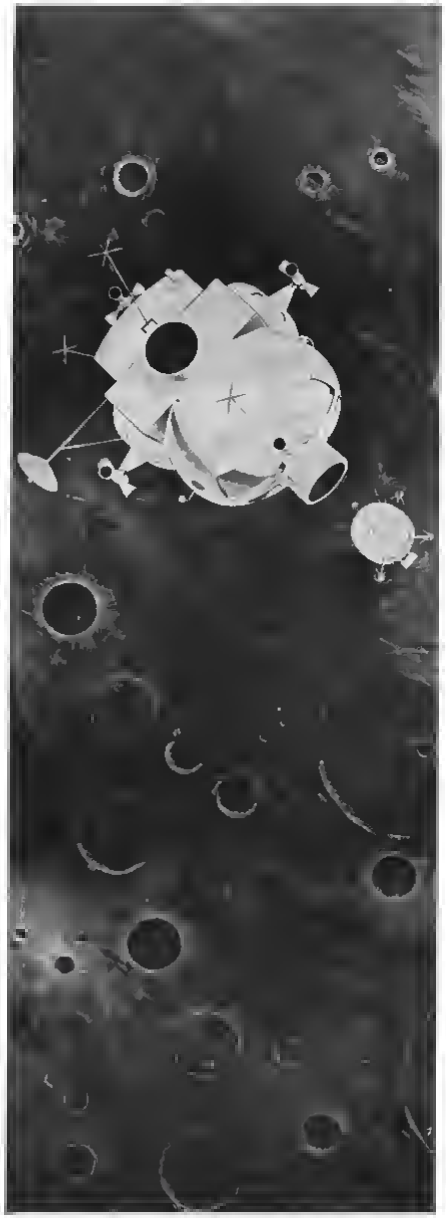
Helicopter Pilots: If you are interested in career employment, have minimum 400 hours first Pilot helicopter time, are under 33, weight less than 175 pounds, contact Petroleum Helicopters, Lafayette, Louisiana. An equal opportunity employer.

POSITIONS WANTED

Aerospace Engineer. MS. 12 years R&D major firm. Group leader. Recent experience space vehicle research and contract proposal studies, nuclear technology, materials engineering, processing research. Desire challenging work. Available PW-1501, Aviation Week, P.O. Box 12, N.Y. 16, N.Y.

ATR, DC-3, DC-7, Comm'l & E. Rotorcraft S-61, 3000 hrs. BS(ME) degree, operations, training and A.S.W. background. Presently Captain military DC-8, Trans-Pacific routes. Desire position as Pilot, corporate or airline with or without additional responsibility, i.e. sales, training, operations, etc. Age 31, married, 2 children. Will travel, relocate (foreign). Resume on request. Available April 15. PW-1511, Aviation Week, P.O. Box 12, N.Y. 36, N.Y.

Professional Jet Test Pilot 17 yrs., 6500 hrs. Desire fly mk/liaison/sales for company needing experienced dependable. Inst. coverage by private or furnished aircraft. PW-1528, Aviation Week, P.O. Box 12, N.Y. 36, N.Y.



LUNAR LANDING AND RENDEZVOUS PROGRAM OFFERS ENGINEERS & SCIENTISTS THE GREATEST TECHNICAL CHALLENGE OF OUR TIMES

The selection of Grumman to design, develop and fabricate the NASA Lunar Excursion Module (LEM) which will be used to achieve the Apollo program's goal of landing astronauts on the moon, opens a new chapter in the conquest of space. Boosted by a three stage Saturn C-5 vehicle, the Apollo spacecraft will enter lunar orbit and LEM will separate from the spacecraft to begin its epoch-making descent to the lunar surface.

Later, it will launch itself back into orbit and rendezvous with the Apollo Command and Service Modules permitting the lunar astronauts to return to earth, while the LEM is jettisoned into lunar orbit.

The Lunar Excursion Module and other space programs at Grumman are creating unprecedented professional opportunities at the company. Make 1963 a year of personal achievement in an endeavor that ranks among the greatest of all times. Current requirements are detailed on the next page. We invite your inquiry on the attached inquiry form or by personal resume to Mr. W. Brown, Manager Engineering Employment, Dept. GR25.

GRUMMAN
AIRCRAFT ENGINEERING CORPORATION
Bethpage · Long Island · New York
(An Equal Opportunity Employer)

PROFESSIONAL PLACEMENT INQUIRY

For your convenience and to facilitate your inquiry, please use this form. It will enable the professional staff at Grumman Aircraft to evaluate your background and experience and arrange for a mutually convenient personal interview. All inquiries will be held in strictest confidence. Enclose in an envelope and send to Mr. W. Brown, Manager, Engineering Employment, Dept. GR25 Grumman Aircraft Engineering Corp., Bethpage, L.I., N.Y.

NAME_____

STREET ADDRESS_____

CITY & STATE_____ TELEPHONE_____

NEAREST MAJOR CITY (IF APPLICABLE)_____

COLLEGE GRADUATE: YES___ NO___

Degree	Subject	Year

Major Specialty_____ Yrs._____ Other Specialty_____ Yrs._____

Applying for position(ns)(of)_____

Background and experience (Brief resume of experience, recent history of employment)

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

ENGINEERS & SCIENTISTS

Explore these immediately available positions:

Structural Designers—BS in CE, ME or AE with experience in light weight space vehicle design. Familiarity with materials in space environment and pressure vessel design essential.

Cryogenic Heat Transfer—Engineers and physicists with BS or MS and 3 years background in cryogenic tankage heat transfer to perform detailed analysis of configurations for main propulsion system and for other smaller low temperature containers. Will initiate experimental programs as necessary to verify analysis.

Temperature Control Engineers—BS or MS and 2 years experience in missile space vehicle temperature control system analysis. Should have background in radiative heat exchange and thermal coatings as applied to passive and active temperature control systems.

Electronic Cooling Engineers—BS or MS and 2 years experience to perform challenging work on both high density air and liquid cooled electronic equipment and electronic equipment which must operate in a vacuum. Must be able to perform detailed analyses of equipment cooling requirements and initiate necessary thermal tests.

Internal Aerodynamicists—BS or MS in AE, ME with minimum of 3 years experience in Fluid Dynamics work applicable to liquid rocket propulsion systems, nozzle flow analyses, pressurization system design, throttling performance; injector and thrust chamber propellant flow analysis.

Gas Dynamicists—BSME or MS with minimum of 3 years experience and capability to perform analyses and tests of reaction jet control systems, jet exhausts, and gas lubricated bearings.

Reaction Control Engineers—BS degree plus a firm background in small liquid rocket engines analysis and testing. Will be responsible for the development of liquid rocket attitude control system for manned space vehicle.

Test Analysis Engineers—BS degree plus 3 to 5 years direct rocket test experience to work on manned space propulsion liquid rocket engines and propellant systems. Must have ability to plan test programs and analyze test results to evaluate overall performance characteristics.

Rocket Propulsion Engineers—Engineers with 2-5 years of direct experience in the analysis, design, development and testing of liquid rockets. An advanced degree and additional experience in propellant analysis, IBM programming, and proven ability in the field of liquid rocket engines is required. Work involves development of advanced liquid rocket propulsion systems. Supervision capability is very desirable. Both junior and senior positions available.

Programming Specialists—B.S. or M.S. in engineering, physics or mathematics with 4 years experience in Electronic Data Processing. To generate original programs and analyze coding of existing programs. Knowledge of IBM 7090 and 1620 machine coding is considered essential. Programs involve matrix algebra operations, time dependent solutions and integrations. Experience in analog-digital programming would be useful but not essential.

Acoustics & Environmental Vibration—B.S. or M.S. in M.E. or A.E. with a minimum of 3 years experience in environmental vibration analysis of Aerospace structures and equipment. Vibration or acoustical testing experience is desirable. Opportunity to work on environmental vibration design problems for spacecraft.

Vibration Test Engineers—B.S. or M.S. in A.E. or M.E. with 2-5 years experience in vibration testing. Will plan and conduct vibration tests on spacecraft, analyze and interpret data, write reports, perform vibration analyses required for support of test. A working knowledge of current instrumentation, measuring and recording devices and techniques is required. Opportunity to perform original work, assume responsibility and travel to perform tests in outside facilities.

Space Dynamicists—B.S. or M.S. in Physics, Applied Math or Applied Mechanics with a minimum of 5 years experience in the analysis of flight dynamics with at least 2 years experience in space dynamics, e.g. disturbance torques, orbital mechanics, lunar trajectory analysis, and separation system dynamics.

Guidance Dynamicists—B.S. or M.S. in A.E., E.E., M.E. or Applied Mechanics with a minimum of 2 years experience in the analysis of guidance systems for spacecraft. To analyze and evaluate inertial configurations and dynamic characteristics of radar, IR, optical and inertial guidance loops, signal processing and error analysis. Background in sample-data and non-linear controls systems analysis techniques is desirable.

Control Dynamicists—B.S. or M.S. in A.E., E.E. or M.E. with a minimum of 2 years experience in analysis of control systems for spacecraft. Will evaluate automatic flight control system stability and performance. Familiarity with non-linear techniques, digital control techniques and adaptive control techniques is desirable.

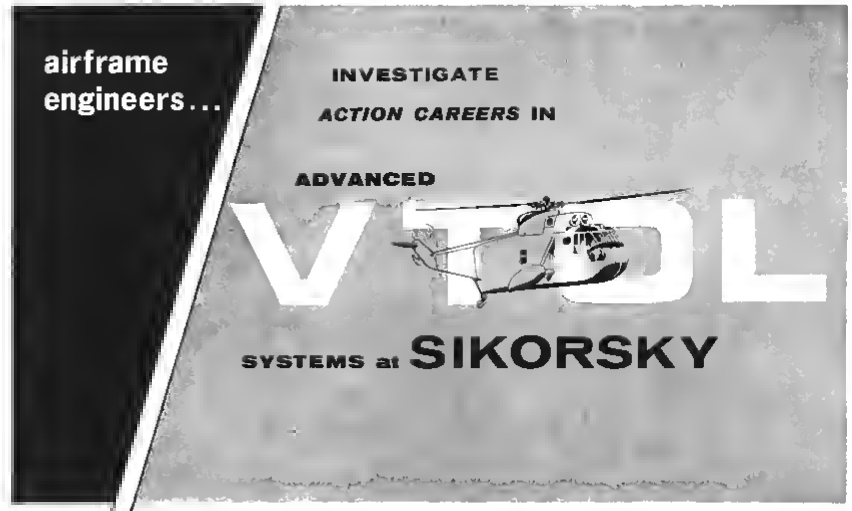
Make 1963 a year of personal achievement in an endeavor that ranks among the greatest of all time. Mail the attached inquiry form to Mr. W. Brown, Manager, Engineering Employment, Dept. GR25

GRUMMAN

AIRCRAFT ENGINEERING CORPORATION

Bethpage Long Island New York

(An Equal Opportunity Employer)



We are looking for men who welcome the demanding challenge of permanent and rewarding assignments . . that of further advancing the world's most versatile vehicles —Sikorsky VTOL aircraft.

Long a world leader in helicopters, we are expanding strongly into ever widening areas of VTOL application. And we need men who can help build towards the fascinating future ahead. What tomorrow may hold can be gained by the many jobs being performed by Sikorsky VTOL systems today. This diversity spans: **space capsule recovery • anti-submarine systems • equipment and personnel transport • rescue missions • airport passenger travel • industrial transport and personal transportation •**

It's a new and exciting era for the airframe engineers who can match their growth to ours.

HERE ARE SOME OF THE AREAS OF OPPORTUNITY:

AERODYNAMICS • AIRFRAME DESIGN • AIRCRAFT STRUCTURES

MYLAR DESIGNING • WEIGHT CONTROL • PRELIMINARY DESIGN

LIVE A FULL LIFE IN CONNECTICUT

Stratford, Connecticut, has the things that count for living, working, playing. Here are pleasant villages, suburban living, medium-sized cities—and—less than an hour and a half's drive by parkway, the center of New York City. It's a lovely area, replete with excellent educational facilities—varied cultural activities—and for outdoor fun . . . beaches, mountains, ski resorts, golf and yacht clubs.

ACADEMIC ADVANCEMENT

Further enhancing an ideal professional environment is the opportunity we offer engineers to earn advanced degrees through a corporate-financed Graduate Education Program. These programs are available at such accredited schools as Yale University, Rensselaer Polytechnic Institute (Hartford Graduate Center) and Columbia University.

Send your resume, in confidence, stating salary requirements, to:
Mr. Leo J. Shaivoy, Engineering Personnel.

Sikorsky Aircraft DIVISION OF UNITED AIRCRAFT CORPORATION

STRATFORD, CONNECTICUT

An Equal Opportunity Employer

ENGINEERS ■ SCIENTISTS

important & immediate opportunities

at
PRATT & WHITNEY AIRCRAFT
In
CONNECTICUT or FLORIDA

We are seeking competent and creative people who can help advance our programs in the dynamic and fast moving field of **energy conversion**. Today in addition to concentrated research and development efforts on advanced gas turbines and rockets we are exploring new and exciting avenues in every field of aerospace marine and industrial power application—ranging from fuel cells to thermionic generators.

And the environment... be it picturesque Connecticut or bright Florida is excellent for living working playing. Other advantages are **a corporate-sponsored graduate study program—excellent engineering environment and facilities—and company-funded research and development programs amounting to multi-millions of dollars annually.**

WE HAVE IMMEDIATE OPENINGS IN THE FOLLOWING FIELDS:

THERMODYNAMICS—HEAT TRANSFER
MISSILE & SPACE VEHICLES
MECHANICAL DESIGN
STRUCTURES
FLUID MECHANICS
PERFORMANCE ANALYSIS
AIR-BREATHING PROPULSION CONCEPTS EVALUATION
STRESS ANALYSIS—VIBRATIONS
EXPERIMENTAL TEST
SYSTEMS ENGINEERING
CHEMISTRY
NUCLEAR AND THERMIONIC POWERPLANTS
METALLURGY—CERAMICS
NUCLEAR ANALYSIS
REACTOR OPERATIONS
FUEL CELL TECHNOLOGY

Many other openings for engineers and scientists at various experience levels are also available in important programs. If your specialty or field of interest is not listed here, write us—regardless.

Please submit your resume in confidence, stating salary requirements, to either:

MR. P. D. SMITH
PRATT & WHITNEY AIRCRAFT
400 MAIN STREET
EAST HARTFORD 8, CONN.

—or—

MR. J. D. MORTON
PRATT & WHITNEY AIRCRAFT
WEST PALM BEACH
FLORIDA

Pratt & Whitney Aircraft
DIVISION OF UNITED AIRCRAFT CORP.
An Equal Opportunity Employer

STRESS ANALYSTS

AE's, ME's, CE's,
NAVAL ARCHITECTS

Apply
Your Knowledge
of Stress Analysis
—and ADD TO IT
in a Unique Field
the

NUCLEAR POWERED SUBMARINE!

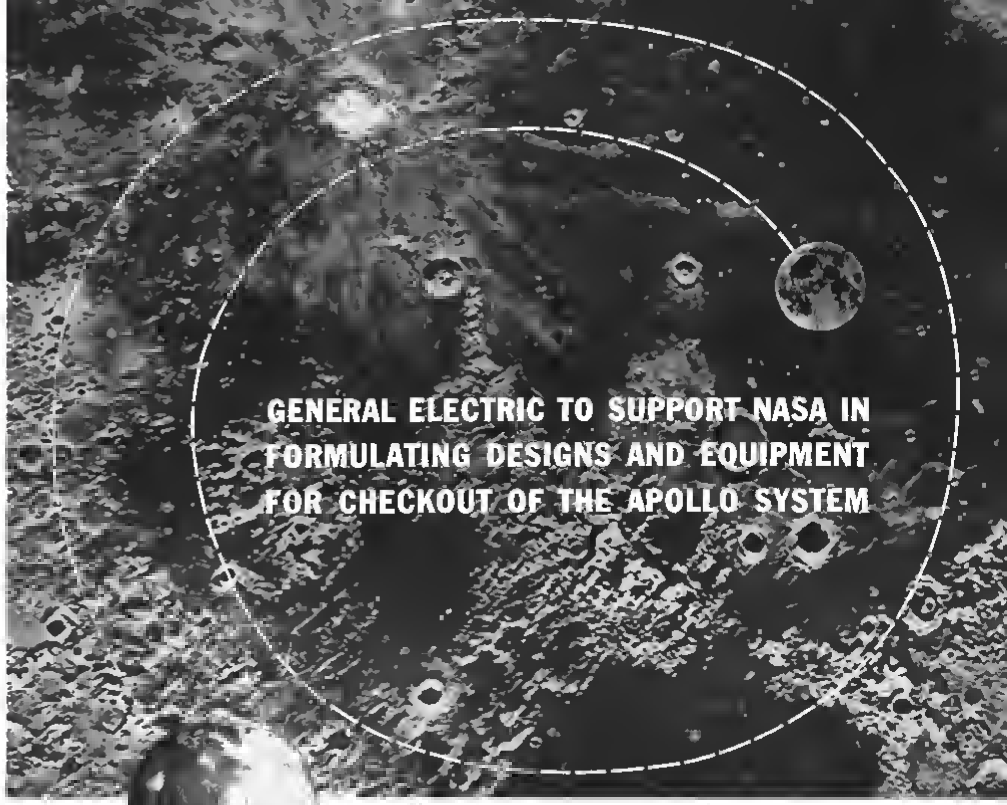
To meet the challenge of new weapons and explosives, an Engineering Group has been formed at Electric Boat to apply the principles of dynamic shock analysis to submarine design. You can join this group in the creative search for submarine hull structures and machinery foundations to withstand high impact shock.

These engineering specialists will be concerned with:

1. Design and analysis of basic hull structural members.
2. Engineering and analysis of machinery foundation structures, using advanced techniques to obtain maximum resistance to dynamic loads.
3. Noise reduction studies leading to development of structures having good noise transmission characteristics. Knowledge of acoustics and vibration theory helpful for this work.

To arrange a convenient appointment, send a resume to James P. O'Brien

GD
GENERAL DYNAMICS
ELECTRIC BOAT
Groton, Connecticut
AN EQUAL OPPORTUNITY EMPLOYER



The National Aeronautics and Space Administration has assigned to General Electric a major role in designing and developing integrated, automatic checkout and test equipment for the APOLLO program, in addition to supporting NASA in overall reliability of the entire system. High level specialists and systems people are being drawn from many components of the company to contribute to the design and development of computerized semi-automatic and automatic checkout systems. Additional highly qualified engineers and scientists are needed now.

Assignments are at HUNTSVILLE, ALABAMA

Engineering experience required in
SYSTEMS and SUB-SYSTEMS CHECKOUT and TEST PLANS, DESIGNS and OPERATIONS

Electrical ■ Electronics ■ Mechanical ■ Conversion and Guidance ■ Propulsion ■ Instrumentation and Communications ■ Telemetry ■ Pyrotechnic ■ Vehicle Systems ■ Systems Specifications and Designs ■ Digital Command Systems ■ PCM ■ Computers ■ Display ■ Analog and Digital Simulation ■ Test Simulation ■ Vibration Analysis ■ Space Mechanics ■ Operational Support Systems.

If you have experience in any of the listed areas, write us today (include salary requirements). Your inquiry will be held in strict confidence. Write to: Mr. P. W. Christos, Professional Placement, Section 64-M, Apollo Support Department, General Electric Co., Support Building, Daytona Beach, Florida.

APOLLO SUPPORT DEPARTMENT

GENERAL ELECTRIC

An Equal Opportunity Employer

Specific Career Positions at NASA

Outstanding Opportunities Available Immediately
At NASA Centers in Maryland, California, Texas, Alabama and Ohio

The career positions outlined below bear a direct and significant relationship to the nation's space effort.

Respondents should have a BS or advanced degree from an accredited college or university. Please send your inquiry to the Personnel Offices of the appropriate NASA center, as indicated below.

NASA GOODARD SPACE FLIGHT CENTER
Dept NC-2, Greenbelt, Maryland (Suburb of Washington, D. C.)

Satellite Tracking

Various positions at beginning through senior level involving research, design and development of optical and electronic devices and systems. Also openings in Systems Analysis and Evaluation and in management of Overseas Tracking Stations. BS or higher in EE, Mathematics or Physics preferred.

Communication & Data Acquisition Program Management

Technical management for development of satellite communication and data handling subsystems. Positions require laboratory experience in design of miniaturized electronic flight hardware.

Systems Analysis

For evaluation and systems design of complex data processing facility utilizing special purpose telemetry reduction equipment and large scale digital computers. Background in computer systems design, digital computer programming or data analysis.

Spacecraft Heat & Light Control

Development of thermal analysis techniques. Thermal design of spacecraft, design and development of passive and active temperature control systems, research on coatings with precise optical properties, development of techniques for rapid and reliable measurement of optical properties in infrared, visible and ultra-violet. Includes consideration of effects of the space environment, including vacuum, ultra violet irradiation, electron and proton bombardment and thermal stress.

Electronic Flight & Support Systems

Design, coordination and integration of all electronic subsystems for satellites. Beginning through senior level openings for Electronic Systems Engineers.

Space Vehicle Project Management

Rocket launching analysis and evaluation of rocket vehicle flight performance. Includes development of techniques for acquiring and evaluating data, design and modification of rockets for specific payload requirements, trajectory studies, stress and vibration analysis and technical management of rocket vehicles. Beginning through senior level openings for Engineers, Physicists, Mathematicians.

Flight Systems Test

Test and evaluation in areas of stress, magnetics and vibration. Beginning through senior level openings.

NASA FLIGHT RESEARCH CENTER
Dept NC-1, Edwards, California

Automated Control Systems

Plan and conduct research, design, modification and development work in application and instrumentation systems required for vehicle guidance, control and navigation programs. BS in EE, Electronics option preferred. Three years experience in design and development of control and guidance hardware.

Radio Frequency Systems

Airborne vehicle tracking, data acquisition and data transmission. BS in EE, Electronics option preferred. Three years experience in tracking, data acquisition and data transmission. Digital machine experience at design level required. Telemetry and communication experience desirable.

Supersonic Aerodynamics

Parametric studies of configuration components as related to lift, drag and stability characteristics. Evaluate designs and ideas on problems of supersonic and hypersonic configuration aerodynamics. Flow field effects on design—a major consideration. BS or advanced degree in aerodynamics preferred; three to five years experience in configuration and flow field studies.

Control & Guidance Systems

Conduct tests and evaluations of linear and non-linear control and guidance systems. Consult on systems analysis problems related to human participation and automatic flight control systems. Develop criteria for control and guidance systems analysis, hardware development and flight evaluation. BS in Engineering, Physical Science or Mathematics preferred, including courses in aerospace sciences and mathematics beyond ordinary differential equations. Four years control and guidance systems design, test or analysis experience.

Reliability & Quality Assurance

Analyze raw parts failure data to establish a numerical reliability of systems and components of the X-15 Research Aircraft. Establish reliability prediction techniques—predictive criteria will be applied to future research vehicles. BS in Engineering with a mathematical capability in statistical analysis and prediction techniques. Experience in reliability engineering groups desirable.

Structural Mechanics

Research in vibration dynamics and structural thermoelasticity. Management responsibility. Submit and plan research projects. BS in a Physical Science and five years' professional experience in structural research preferred.

Flight Mechanics

Investigation of the responses of vehicles to larger flows and associated flight phenomena involving aerodynamic effects, guidance and control systems, etc. BS in Aeronautics, Aeronautical or Mechanical Engineering or Engineering Mechanics. Minimum of three years experience with demonstrated ability to perform high level research.

NASA AMES RESEARCH CENTER
Dept NC-1, Mountain View, Calif.

Solid State Circuitry

NASA's Space Sciences research programs require engineers to design and develop solid state circuitry for use in scientific instruments in existing and future flight programs. Openings at both intermediate and senior levels. MSEE preferred.

Light Measurement

Includes the design of optical, telescope, and spectrophotometers for infra-red and ultra-violet astronomical observation. Applied physics or optical engineering background.

Satellite Instrumentation Packaging

Includes the design of minimum weight structures for the packaging of circuits and instruments; also for thermal and stress analysis of these structures. Openings at intermediate and senior levels. BSME or MSME preferred.

NASA MANNED SPACECRAFT CENTER
Dept NC-1, Houston, Texas

Space Sciences

Physicists experienced in Geodesy, Astronomy, Astro-Sciences and Geophysics for work in developing manned spacecraft mission, including simulation of space environment for Projects Gemini and Apollo. Intermediate and senior level openings.

Propulsion & Power

Aeronautical engineers experienced in liquid and/or solid propulsion with emphasis on nozzle design. Few patterns gas dynamics and spacecraft design. Intermediate and senior level openings.

Fluid & Flight Mechanics

Mechanical Engineers experienced in thermo dynamics, heat transfer, thermal control, fluid flow, landing systems (parawing, rotor systems, parachute) and spacecraft components. Intermediate and senior level openings.

Data Acquisition Systems

Electronic Engineers experienced in data acquisition, computer operations, computer programming and control and guidance systems. Intermediate and senior level openings.

NASA LEWIS RESEARCH CENTER
Dept NC-1, Cleveland, Ohio

Propulsion Components & Systems

Experience with cryogenic tanks and valves, turbo machinery, dynamic controls, thrust chambers, gas generators, heat exchangers, systems analysis and systems testing. Research on heat transfer, lubrication and bearings, fundamental flow processes, tank pressurization and turbopumps. Intermediate and senior level openings.

Reliability & Quality Assurance

Analysis and appraisal of specific hardware and systems designs. Develop standards to judge reliability and performance, together with appropriate test plans for materials and equipment testing. Establish procedures and systems to assure maintenance of hardware and equipment to specifications. Failure analysis of defective components and systems.

Facilities Engineering

Design and construction of large scale engine test and space environment facilities; analyze test requirements, design test chambers, support systems, handling facilities, operating techniques, instrumentation and control systems for specific tests. Beginning to senior level openings.

Project Development Engineering

Engineering analysis of project requirements, develop schedules and test plans, analyze test results, contractor reports, project review, detail liaison with contract representatives and other technical management responsibilities.

Mission Analysis & Application

Analysis of mission requirements in terms of flight paths, orbits, payloads, propulsion, control and guidance, configuration and matching studies of vehicles, boosters and their combinations, energy management studies, studies related to orbital rendezvous and landings on planetary bodies. Beginning to senior level openings.

Vehicle Structures

Conceive and design vehicles to meet particular space flight requirements. Includes structural analysis, size and weight studies, systems layout, power and propulsion requirements, materials selection.

Ground Support Equipment

Design and development of ground support systems for checkout and launching of specific payloads and stages.

Nuclear Propulsion & Power Systems

Scientists and Engineers skilled in Nuclear Reactor Technology, radiation and shielding, materials deterioration and nuclear rocket heat transfer studies. Other work specialties concerned with the operation and performance of experiments in a 60 megawatt experimental test reactor at our Plum Brook Station at Sandusky, Ohio. Intermediate and senior level openings.

Space Power Generation

Mechanical, fuel cell and solar cell systems. Research Engineers and Physicists skilled in liquid metals technology, magneto hydrodynamics, refractory coatings, turbomachinery, fluid dynamics and heat transfer, electric generators, power conditioning, thermionics, physical metallurgy and lubrication, environmental testing, system controls. Research on direct conversion of thermal, solar or nuclear energy to electrical energy. Involves semiconductor and plasma energy conversion devices. Beginning to senior level openings.

NASA MARSHALL SPACE FLIGHT CENTER
Dept NC-1, Huntsville, Alabama

Automated Control Systems

Research in Theoretical Physics, Aerodynamics and Mathematics including establishing trajectory for space vehicles and evaluating flight mechanical parameters. Also will include pre-flight and post flight evaluation of space vehicle or spacecraft flight and systems. Beginning and senior level openings. BS or MS in Physics, Mathematics or Aeronautical Engineering preferred (min. 20 semester hrs. in Physics).

Field & Flight Mechanics

Solution of advanced theoretical space vehicle and spacecraft problems in one or more of these areas: Aerodynamics, Flight Mechanics, Guidance and Control and Vehicle Performance with emphasis on system conceptualization. MS or PhD in Physics, Mathematics or Aeronautical Engineering preferred.

Space Sciences

Participate in space vehicle and spacecraft theoretical atmospheric physics studies in one or more of these areas: Wind Turbulence, Wind Shear, Model Atmosphere and Terrestrial and Space Environmental Conditions. BS or MS in Physics preferred with min. 20 semester hrs. in Meteorology.

Flight Mechanics

Theoretical research studies for space vehicle in one or more of these areas: Optimization of Space Orbits, Sensitivity of Orbits to Celestial Influences, Development of Analytical Formulation of Space Flight Orbits, Atmospheric Re-entry Flights, Stability and Control of Rigid Bodies, Guidance Control Systems and Flutter and Vibration. BS or MS in Physics, Mathematics or Aeronautical Engineering (min. 20 semester hrs. in Physics).

Measurement & Control Systems

Solution of aerodynamic, electronic and instrumentation problems requiring analysis and evaluation of electronic measurement and instrumentation systems for experimental aerodynamic wind tunnels, space simulation and allied facilities. BS or MS in EE or Physics.

Measurement Standards & Calibration

Theoretical research studies for space vehicle in one or more of these areas: Optimization of Space Orbits, Sensitivity of Orbits to Celestial Influences, Development of Analytical Formulation of Space Flight Orbits, Atmospheric Re-entry Flight, Stability and Control of Rigid Bodies, Trajectories and Guidance and Control Theories. Beginning through senior level openings. BS or MS in Physics or Mathematics preferred (min. 20 semester hrs. in Physics).

NASA is an equal opportunity employer. All positions filled in accordance with Aerospace Technology Announcement 252-B.

ADVERTISERS IN THIS ISSUE

AVIATION WEEK, FEBRUARY 25, 1963

TACTICAL MISSILE SCIENTISTS AND ENGINEERS

The Columbus Division of North American Aviation has recently established a tactical missile product line based on years of research and development. Opportunities for professional recognition and advancement are available.

Programs exist in the project stage, research and development stage, and advanced concept stage. Experienced Engineers and Scientists with BS, MS and PhD Degrees are needed in the following areas of specialization:

- Aerodynamics
- Heat Transfer
- Structures
- Power Systems
- Propulsion
- Control Systems
- Micro Miniature Circuits
- Dynamics
- Guidance Systems
- Radar and Infrared Systems
- Systems Engineering
- Missile Design
- Ground Support Equipment
- Operations Analysis
- Target Signature Analysis

Please send resume to:

**Mr. H. Keever, Manager
North American Aviation,
Professional and
Technical Employment,
Box AW 583
4300 East Fifth Avenue,
Columbus 16, Ohio**

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

**COLUMBUS DIVISION
NORTH AMERICAN AVIATION**

LETTERS

Value Analysis

Mr. H. E. McDonald's remarks about the Martin-Orlando Value Analysis Operation in his letter to the editor (AW Jan. 14, p. 126) need some clarification.

Martin's Value Analysis/Engineering Program was inaugurated in 1945 (one of the first in industry), and organizationally was located in the Engineering Div. Since then the program has been expanded to cover all areas—Manufacturing, Quality, Procurement, Administration, etc. The reason it was located in the Engineering Div. is obvious, almost all product costs and problems are created during design. Although a comprehensive "after the fact" effort is conducted, the emphasis is placed on the design or its conceptual stage.

The statement that the 70% cost reduction achieved on one of our programs "was due mostly to a predictable fact known as a 'learning or experience curve'" is difficult to understand. Of the many applicable learning and experience curves resulting from the theory originated by Mr. T. P. Wright in 1936, none will give a "70% reduction in product cost. Learning and experience curves did contribute to the cost reduction, but the bulk of the cost reduction was the result of an attack, by Martin and its suppliers, on the function of each detail, part, subassembly, equipment, etc. Incidentally, these cost reductions were over and above those achieved at the design concept stage which are usually more difficult to measure and very seldom recorded.

J. L. Dorio
Martin Orlando VA Staff
Orlando, Fla.

Underwriter's Reply

As an aviation accident underwriter, I was extremely dismayed to see your magazine publish in its July 30 issue (p. 94) a letter from an airline pilot alleging that the insurance companies are responsible for suicides who cause the death of other airline passengers.

I should think that a magazine like yours, as outstandingly accurate as it usually is, might have had recourse to investigate the facts concerned before publishing such a letter.

The letter says that "... prospect of financial gain still exists for the beneficiaries of large airline trip insurance policies." As the person in charge of underwriting flight insurance policies for my firm I can assure you this is not the case.

First of all, no one insured may take out more than $75,000 of flight insurance from any one company. Secondly, the standard flight insurance policy excludes losses caused by suicide. Thirdly, should a proposed beneficiary be responsible for an airline crash, no insurance company would pay that beneficiary's claim as this would clearly be against public policy.

Therefore, the allegations made in the letter you published are purely false. No insured could have his estate profit by his own suicide under such vending machine policies.

Whereas that letter-writer proposed that changes be made in existing insurance policies, I should like to propose instead that your magazine publish these facts so that prospective suicides may be deterred from their act by noting that their estate or beneficiary would have nothing to gain.

Perhaps this seems unnecessary to say, but the fact is that the purpose of flight insurance policies is to provide an economical way for the average persons to leave behind a good deal of money should his death be accidentally caused. It is, then, only for the benefit of society that these policies are made available—not for the sake of causing undue suffering and harm.

Robert Lawrence
Aviation Accident Underwriter

Long Ring Contest

I would like to propose a new contest for all airline users—particularly those wishing to obtain flight information over the telephone. The following rules should apply:

- Obtain the desired airline phone number from the information operator.
- Dial the number and let it ring.

That's all there is to it. The winner is that person who has to ring the longest before the called airline answers.

I would like to submit my attempt: comprising three consecutive calls of one, two and three minutes waiting respectively to Eastern Air Lines. My wife is currently working on a fourth try, but we will have to forward the waiting time information at a later date. I expect to be mailing this letter before we hang up after a fourth unsuccessful try.

I suggest that you keep records of all entrants; the winner being given one opportunity to contact by phone the airline of his choice with a maximum wait of 15 sec.

S. A. Fierston
Swampscott, Mass.

Last Jet Straw

The single-class service proposed by United Air Lines is the last straw in the jet plane fiasco. The airlines made two serious mistakes when they introduced jets. They overestimated traffic growth and they failed to foresee the diversion from first class to coach service that occurred when flight times were reduced. As a result, too many jets which now fly about half-empty, were ordered, and the airlines retired their piston planes as rapidly as possible thereby losing the opportunity to establish a meaningful distinction between first class and coach service.

If a single class service is adopted, the entire financial burden caused by these airline miscalculations will fall on the coach passenger. Five years ago a nonstop, cross-country flight took nine hours and the round-trip coach fare was $200. With single class service the fare will be over $300 for a five-hour flight. Very few non-business passengers are interested in saving time at a cost of $13 an hour. On the other hand, the single class fare would be less than the old first class piston fare.

If the airlines want single class jets they should be requested to resume piston flights. It is inconvenient for them, perhaps the CAB should consider licensing a new airline which would provide economical piston service. The success of Icelandic Airlines amply demonstrates the demand for such service.

Richard Rosenbaum
Palo Alto, Calif.

How Come?

How come we can pay over $53 million ransom for Cuban prisoners of war, additional millions of dollars for military aid to "non-aligned" India, and billions of dollars to land a man on the moon and yet cannot afford to provide MATS with adequate funds to continue its call-flying policy with the airlines? How come freight is backed up so badly that in many instances there is no longer warehouse space left in which to store it? How are the logistical requirements of our armed services to be met? How come thousands of trained airline personnel are unemployed because of the absence of call-flying? How can the airlines and their personnel be expected to maintain an interest in MATS flying when costly equipment sits idle and crew training costs go down the drain? Why can't we get a little money for our side?

Howard L. French
Unemployed Airline Pilot
Seattle, Wash.

Conspicuous Absence

On the evening of Jan. 29 the American Broadcasting Co. telecast a Documentary Special entitled "Big Bomber Battle." During this program several United States Air Force bombers were mentioned but the B-58 was in my mind, conspicuous by its absence. Why?

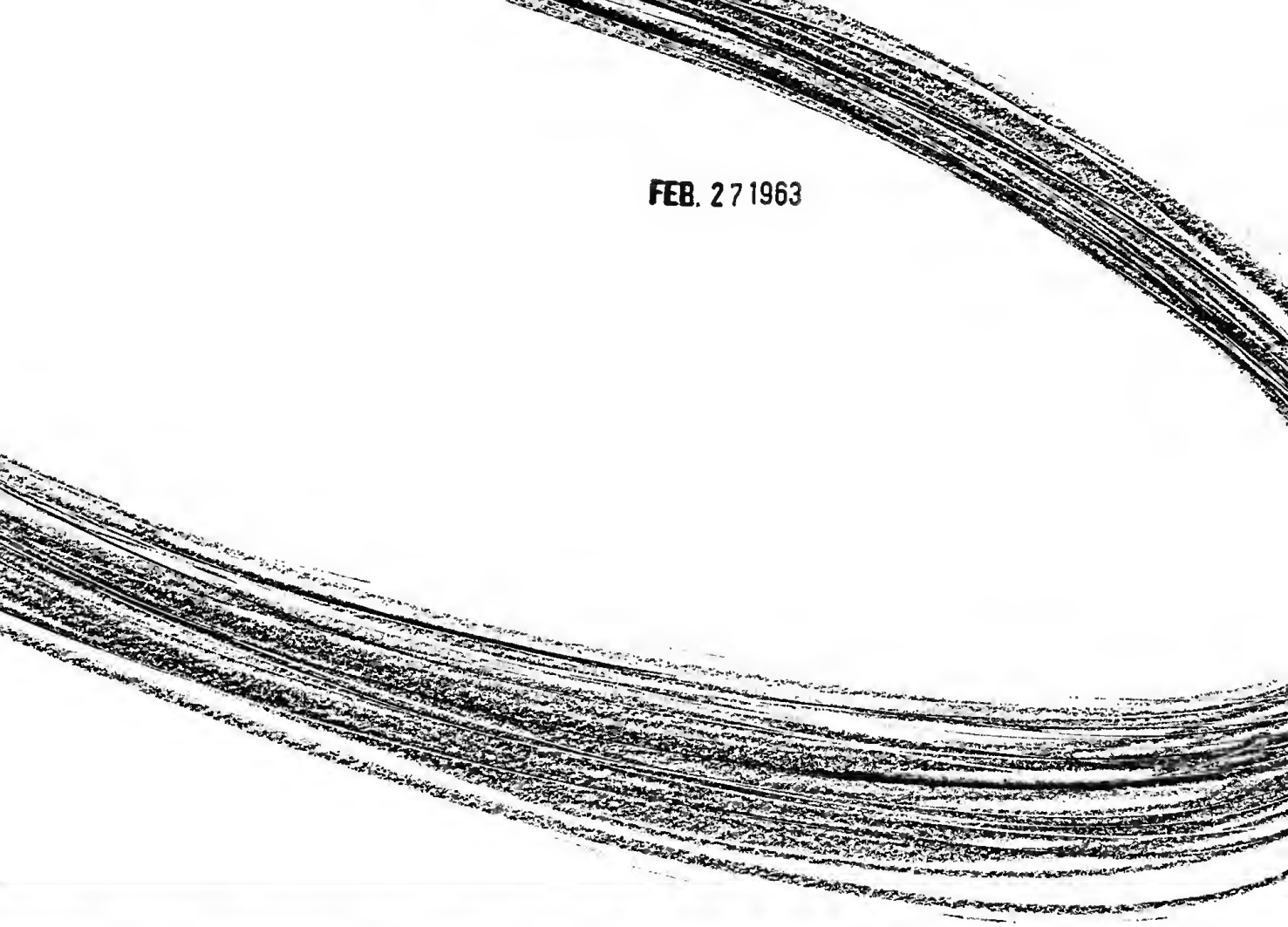
The federal government has spent in excess of $4 billion developing an aircraft which I'm led to believe has tremendous potential. Why isn't this potential being recognized and utilized? What is happening inside the Air Force to stifle the B-58 program? Why is the B-58 being ignored? Has the Air Force made the best possible use of the B-58? Has the Air Force been objective in the handling of the B-58 through development and now in its operational status?

These are a few of the questions I feel should be answered before the aircraft is relegated to the scrap heap and/or more dollars are spent on new aircraft in the same class.

Data is available which demonstrates the capability of the B-58 to bridge the gap between the operational B-52 and the proposed RS-70. Why isn't the data being used?

Discussions I have had with one of my associates who incidentally has considerable operational experience in a B-58 has deepened my concern with the apparent waste. I sincerely feel that the $4 billion already expended entitles the taxpayers to an explanation.

Howard E. Conlon
Ann Arbor, Mich.



3,011 orbits extra.

The Satellite Injun I was launched in June, 1961, to transmit radiation levels from space. Its nominal life expectancy was approximately one year. Today, after 19 months and more than 8,000 orbits, Injun I is still functioning, filling almost a mile of magnetic tape with data every day.

The people who designed and built Injun I—under the direction of Dr. Brian J. O'Brien and Dr. J. A. Van Allen at the State University of Iowa—are proud of its performance. So are we. Over two-thirds of the transistors and diodes used in the Injun project—including both Injun I and a subsequent satellite, Injun III—are Fairchild products.

FAIRCHILD
SEMICONDUCTOR

FAIRCHILD SEMICONDUCTOR / A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION / 545 WHISMAN ROAD, MOUNTAIN VIEW, CALIFORNIA / YORKSHIRE 8-8161 / TWX 415-969-9165